"TELEPHONE TESTING AND FAULT LOCATION" IN THIS NUMBER

TELEPHONE ENGINEER

Vol. VI CHICAGO, OCTOBER, 1911 No. 4

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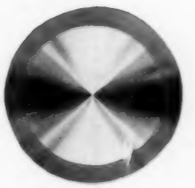

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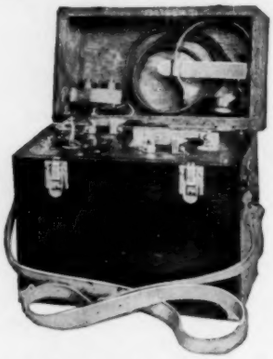

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ESTABLISHED 1902

VOL. VI — CHICAGO, OCTOBER, 1911 — No. 4

PUBLISHED MONTHLY BY THE

ELECTRICITY MAGAZINE CORPORATION

ED J. MOCK and PAUL H. WOODRUFF, Editors.

MONADNOCK BUILDING, CHICAGO.
LONG DISTANCE TELEPHONE: HARRISON 3014.

NEW YORK OFFICE .....1433 Hartford Building, 41 Union Square
Telephone Stuyvesant 1672.
LONDON OFFICE.....36 Maiden Lane, Covent Garden
S. RENTELL & CO., Representatives.

Entered as second-class matter May 26, 1909, at the postoffice at Chicago, Illinois, under Act of March 3, 1879.

TERMS OF SUBSCRIPTION.

United States, Cuba and Mexico	Per year,	$2.00
Canada	Per year,	2.50
Foreign countries within the Postal Union	Per year,	3.00
Single Copy		.20

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CHICAGO, OCTOBER, 1911.

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LOCATING FAULTS.

IN the transmission of speech we are dealing with such delicate forces, such complex phenomena, the wonder is that the apparatus we use and the results we get are as simple and as strong as they are. The subscriber to the modern telephone system reports trouble on his line but rarely; if there is trouble, the company discovers it before he does.

Yet that word trouble has always been associated with the operating of telephones. We have become so accustomed to it, and have used it so freely, that we no longer realize its common significance. For trouble means affliction, distress and grief; and hardly any of the ordinary conditions under which a telephone line goes wrong are serious enough to be so characterized. A sleet-storm visitation is trouble, if you will; but not cross-talk or a grounded line. They are mere incidents in the day's work.

And for this condition we have largely to thank the inventors and designers of clever testing devices—light, handy outfits that do most of the thinking and nearly all the figuring, and point out to us what the matter is and where it is. Today trouble hunting on a telephone line is almost fun—an interesting experiment, of whose result we are sure.

Hardly less wonderful than the telephone itself is our ability to locate exactly the faulty spot in a long wire, without, perhaps, even visiting that spot. The test set is a veritable Sherlock Holmes in its swift, accurate indication of the unseen fault.

Some of those who read the leading article in this number will realize, perhaps for the first time, that no particular technical or mathematical knowledge is required to operate successfully any of the testing equipments described. And with that realization may come a resolution to obtain a modern test set and use it. Such an impulse is a step upward in the progress of the industry. Every telephone man ought to use all the aids science can give him; then would he find that "trouble" was trouble no longer.

RECORDING MEASURED SERVICE CALLS.

OBVIOUSLY, the only equitable method of selling telephone service is by the call, as electric light service is sold by the kilowatt and illuminating gas by the cubic foot. As the New Orleans Board of Trade committee on telephone conditions expressed it, "The flat rate for all patrons whereby a fixed sum is charged for the use of the telephone instrument irrespective of the number of messages sent, is like conducting a restaurant on the plan of hiring a knife and fork to each customer at a fixed rate which would be the same whether a man had the run of the entire kitchen or only ordered ham and eggs."

The flat rate for a single business line in Chicago, for example, is $125 a year. This amounts to about 40 cents a day. Yet there is nothing to prevent such a line being used a hundred times a day, and indeed such use is well within physical possibility. No telephone company can give service at less than half a cent per call. Some other subscriber, who paid the same rate and used his telephone only six or eight times a day, would have to make up the deficit.

So granting without further argument that measured service is a necessary condition to equitable and efficient telephone service, we are nevertheless confronted by the purely technical difficulty of making the measurements—that is, of recording each individual subscriber's call. Nothing could be simpler, of course, than the present method in use by the larger companies. This consists in the manual depression of a lever by the operator, which lever records a number on an electro-mechanical counter. This system has wholly superseded the original method of recording each message on a slip, upon which was noted the numbers of the calling and called subscribers, the date and the operator's number. The system was clerically expensive, and its only advantage over the present counter system was that it furnished material for an itemized account, should any subscriber question the correctness of his bill.

That advantage was a disadvantage to the company; and indeed from the company's standpoint the counter system is perfect. Its accuracy is really unquestionable. Indeed, this very point was submitted by the Baltimore Merchant's Association to its technical advisors, Westinghouse, Church, Kerr and Company, and their report, which follows, exonerates the device from all suspicion:

First. We find that the New York Telephone Company employs an electro-mechanical counter somewhat similar in operation and general construction to a steam engine revolution counter.

Second. In design, construction and installation the registers are substantially and carefully made, in accordance with the best standards in the manufacture of such devices. Each line is supplied with a separate register and all registers for each office are enclosed in a locked dustproof case accessible to responsible officials only.

Third. Each register is direct reading, the message tally from time to time being shown by figures which can be observed through the glass sides of the protecting case, with the case closed.

Fourth. Each message is recorded by the operator in charge of the line originating the call, after the conversation is finished and hence only successfully complete connections appear upon the register.

Fifth. The use of this system, by enabling the operator to do more work, has cheapened the cost of service and enabled the telephone company to reduce rates to its subscribers.

Sixth. The probability of error appears to be reduced to a minimum, and such as may occur seems even more likely to count against the telephone company and in favor of the subscriber.

Seventh. On the whole, the system employed by the New York Telephone Company appears to be reasonable and fair to both subscribers and the telephone company, and as good as the present state of the art will permit.

But unfortunately the public's suspicion rests not upon the device, but upon the company using it. Not yet have the people learned to put implicit faith in the integrity of public utility corporations. The old sentiment dies hard, and the utility of today, innocent as it may be, must suffer for the sins of its forerunners. All the public knows is that with the counter system the opportunity for overcharge is present. The officials of the company may be personally beyond reproach in every way. But the subscriber is paying money for something on a quantity basis when he has no means of checking the quantity. The fact that he could be deceived is reason, in his mind, for supposing that he is deceived.

Many inventors have produced telephone meters intended to operate at the subscriber's station and record his calls before his eyes. None of these devices has been adopted. The inference is that they are not satisfactory. But that very fact unfortunately strengthens the suspicions of the layman.

Undoubtedly the installation of a subscriber's meter would be very expensive to the operating company. It would mean not only the purchase of the instruments and the labor of installation, but also the scrapping of the present exchange meter equipment. But it would be the most satisfactory means to harmonious relationship between the company and the user that could be devised. The telephone company would even be free from the natural suspicion that is now directed at the gas and electric meters—for the cubic gas feet and kilowatts are unknown quantities to the layman, while a call is a call and the telephone meter would be its own check.

It is hardly conceivable that a reliable and practical telephone meter cannot be designed if proper encouragement is offered. Naturally it is not a thing to be decided hastily, and the public should understand that caution is consistent with progressive management.

But the subscriber's meter must come in time, regardless of expense; and like other similar innovations, it will probably be found ultimately to be a splendid investment. For it will banish the last objectons to measured service and so reduce the ranks of the flat rate adherents that the flat rate system can be abolished forthwith. And with every classification of service on a profitable basis there will be little room for regrets over an expenditure for meters.

While on the subject of measured service, a comparison of the two forms of nickel pre-payment service, as being discussed in Chicago at present, may be interesting. The present form of service on the pay station telephones is as follows: The subscriber lifts the receiver, gets the operator's question, gives the called number, is told to "drop a nickel, please," and complies. When the party answers the operator drops the nickel into the coin box. If the line is busy or the party does not answer the nickel is dropped into the return channel.

When the nickel is ready the sequence of operations works smoothly. Frequently, however, the nickel is not ready; the caller cannot find the coin or has some other difficulty, and the called party, having been rung, is impatiently waiting the close of negotiations. The result is unsatisfactory.

The proposed system is this: The calling party drops his nickel first, before he can get the operator. Then if he cannot get his party, the coin is returned as before. The sole advantage is that the commercial end of the transaction is completed before the called party gets on the line, with a consequent absence of embarrassment and interruption.

There has been a great deal of objection to this nickel-first plan, practically all of it ill-advised and uncalled for. The subscriber is deprived of no privileges, and gains in promptness of service because less of the operator's time is required to handle the call.

Even those parasitic calls for the "correct time" or for miscellaneous information are not barred by the nickel-first plan; for the operator is instructed to return the nickel in such cases. It must be admitted, however, that such unremunerative calls would be less under the new arrangement—to the great advantage of both the operating company and the subscribers, who would receive the benefit of the increased operating efficiency.

There is no logical objection to the nickel-first plan of service, and there are many advantages in it to both parties. The Chicago campaign against it is only another example of the popular view that when a public utility contemplates a change of system it is merely looking for an advantage over the public.

STATE CONTROL OF PUBLIC UTILITIES.

COMMISSION control is the order of the day, and the majority of public utility officials recognize in it not only an inevitable condition to be met but an actual benefit. There are some, however, who still mistrust the new order of things and entertain some misgivings as to the success of those future operations which must be subject to the restrictions of a body more or less political in its nature. Superficially, government or state control savors too nearly of government or state operation to be pleasing to the promoter of public utilities who is not familiar with the practical work of such a commission.

Among those states whose public utility commissions have already established reputations for efficiency, Wisconsin stands pre-eminent. Governor McGovern of that state, addressed the recent meeting of governors on the subject covered by the heading of this editorial; and we quote a part of his address because it gives a clear idea of the principles and functions of public utility commissions:

As defined in the statutes of Wisconsin—and this paper is written almost wholly from the viewpoint of my own State—the term "public utility" has a somewhat restricted and technical meaning. It is there employed to embrace only persons, corporations and municipalities that own or operate plants for the conveyance of telephone messages, or for the production and sale to the public of heat, light or power. These utilities, however, are regulated by the Railroad Commission, which, as its name implies, controls also steam and electric railways, as well as express and telegraph companies. In ordinary speech even in Wisconsin therefore all these enterprises are public utilities and it is in this more comprehensive sense that I shall use the term.

It is only of late years that effective administrative control of public utilities through a board of commission has been attempted. Massachusetts in the year 1885 first placed the control of gas and electric utilities in the hands of such a commission. New York established a similar board in 1905. In the same year Wisconsin placed complete regulation of railway service and rates and the control of express companies in the hands of three persons called the "Railroad Commission of Wisconsin." Two years later it added gas, electric heating, water, telephone and telegraph utilities, and street and interurban railways to the supervision of the same body. During the session of the Legislature this year the power of this commission was again enlarged so as to include the regulation and conservation of water powers. Thus all the public utilities of Wisconsin, using this term in its broadest sense, are now subject to the regulation and control of this single board, which, however, still retains its original designation.

A similar tendency toward commission control is observable elsewhere. During the last year Ohio, Kansas, Maryland, New Hampshire and New Jersey passed acts creating commissions similar in part at least to that of Wisconsin. California has submitted its commission act to a referendum vote of the people. During the past two years the legislature of practically every state in the Union has considered the question of establishing some sort of a public utility commission.

The basic legal principles underlying governmental regulation of public utilities, however novel may be their application to present industrial conditions, are as old as the common law. They are founded upon the very elementary distinction between a public and a private calling. One is clothed with a public use and interest, while the other is not; and this public interest has always in the eye of the law justified regulation in behalf of the people as a whole. The nature and character of the business of utilities is such that competition is inoperative in determining service or rates, and the only choice left to the public is between regulated and unregulated monopoly. It goes without saying that the right of the State to supervise monopolies is as ancient as it is obvious.

But it may be urged that the exercise of this power, the enforcement of this right, is a legislative function which cannot lawfully be delegated to an administrative board or commission. This is very true; it does not, however, militate against the practical utility of these commissions. Most assuredly it is the legislature and not the commission that has the power to regulate. It is the legislature that does regulate. It is the legislature that creates the commission, defines its powers, establishes rules for its guidance and determines the entire policy to be pursued. The commission merely ascertains the facts of each case as it is presented, and applies to these facts the law already laid down by the legislature. It is purely an administrative body with administrative functions only, although these functions have become so immensely difficult and important that we sometimes conceive them to be either legislative or judicial in nature, or both. Upon the other hand the rule laid down by the legislature is often a very simple and elementary one; in the case of Wisconsin utilities merely that the service and facilities furnished shall be reasonably adequate, and the rates charged shall be reasonable and just. Manifestly the difficulty here is not in formulating a rule of action, but in applying it.

This relation of the commission to the legislature and also to the courts is so well set forth in the recent case of the Minneapolis, St. Paul and Sault Ste. Marie Railway Company vs. the Railroad Commission of Wisconsin (136 Wisconsin, 146), that I feel justified in quoting from the decision. Answering the objection that the law creating the railroad commission is invalid because it involves an unlawful delegation of legislative power, the Supreme Court of Wisconsin, in a very comprehensive and illuminating opinion, stated the law upon this subject as follows:

"The division of governmental powers into executive, legislative and judicial, while of great importance in the creation or organization of a State, and from the viewpoint of institutional law and otherwise, is not an exact classification. No such exact delimitation of governmental powers is possible. In the process of enacting law there is frequently necessary the preliminary determination of a fact or group of facts by the legislature, and it is well settled that the legislature may declare the general rule of law to be in force and take effect upon the subsequent establishment of the facts necessary to make it operative or to call for its application. . . . The legislature may delegate any power, not legislative, which it may itself rightfully exercise. This power to ascertain facts is such a power as may be delegated. . . . This law establishes, and thenceforth assumes, the existence of rates, charges, classifications and services, discoverable by investigation but undisclosed, which are exactly reasonable and just. It commits to the Railroad Commission the duty to ascertain and disclose that particular rate, charge, classification or service. The law intends that there is only one rate charge or service that is reasonable and just. When the order of the commission is set aside by the court it is because this reasonable and just rate, charge, classification or service has not yet been correctly ascertained. When the order of the commission has been rescinded or changed by the commission because of changed conditions it is because there is a new reasonable rate to be ascertained and disclosed applicable to such new conditions and fixed by force of law immediately when the new conditions come into existence. But the theory and the mandate of the law is that this point always exists under any combination of conditions and is always discoverable although not always discovered. Until it is discovered and made known the former rates and service prevail. The order of the commission is *prima facie* evidence that the rate, charge or service found and fixed by it is the particular rate, charge or service declared by the legislature in general terms to be lawful and to be in force. If it were conceded that the commission had power

or discretion to fix one of several rates, either of which would be just and reasonable, it would be hard to say that this was not a delegation of pure legislative power to the commission. But the theory of this law is to delegate to the commission the power to ascertain facts and to make mere administrative regulations."

"The notion that commissions of this kind should be closely restricted by the courts, and that justice in our day can be had only in courts, is not conducive to the best results. Justice dwells with us as with the fathers; it is not exclusively the attribute of any office or class, it responds more rapidly to confidence than to criticism, and there is no reason why the members of the great Railroad Commission of this state should not develop and establish a system of rules and precedents as wise and beneficial within their sphere of action as those established by the early common-law judges. We find the statute well framed to bring this about."

The Wisconsin law makes no distinction between privately and publicly owned utilities. Both are amenable to the same regulations. Both report their financial conditions in the same manner, and according to the requirements of a uniform system of accounting. This seems reasonable, for the patrons of municipal plants are entitled to the same protection against inefficient management as those of private plants, and a comparison of results obtained under these different systems of ownership has been of real assistance in the regulation of both.

The mere fact of regulation of public utilities contains the implication that they are virtual monopolies; otherwise supervision of them might not be expedient or even justifiable. The Wisconsin statute goes farther and frankly recognizes this condition by providing for the so-called indeterminate permit. Considering that where effective regulation exists competition is neither necessary nor desirable, the Wisconsin law provides that the short-lived franchises held by existing utility companies when it was enacted may be surrendered for indeterminate permits. This enabled the utility to secure a monopoly of the territory it occupied during good behavior, or until the plant should be acquired by the public at a fair valuation. In this way unnecessary duplication of equipment, unnecessary augmentation of fixed charges, and cut-throat competition are prevented, and a more economic and satisfactory service is secured. By doing away with short-time franchises, moreover, a speculative element is eliminated from public utility investments, and the cost of financing enterprises of this sort is reduced.

Thus commission control is protective as well as regulatory —protective of the utility, I mean. The requirement that every person desiring to start a new utility shall first obtain from the commission a certificate of public convenience and necessity further exemplifies this policy. In order that each existing company, so long as it properly serves the public, may be free from fear of invasion of its field by rivals possibly more powerful than itself it is provided that every utility having an indeterminate permit shall have an exclusive monopoly of the business in which it is engaged, except in those rare cases where the commission, after hearing, may determine that public convenience and necessity require a second utility to divide the field or to supplement inadequate or defective service. "Sandbagging" and "paralleling" are thus very properly and effectively outlawed.

The last report of the Railroad Commission shows that seventy-two corporations, representing 37 per cent of the gross earnings from utility business in Wisconsin, immediately upon this law going into effect, decided to exchange their franchises for indeterminate permits. Many others came in afterward. Stability in investments was thus obtained, as appears from the fact that the securities of utilities operating under a permit as a rule command a higher price in the market than those that operate under the old-time franchises. The period within which utilities might thus exchange limited-time franchises for indeterminate permits was at first definitely prescribed by the Legislature, then extended from time to time, and the last session made the indeterminate permit universal and compulsory. At present, therefore, there are no special franchises in Wisconsin.

Another important feature of the Wisconsin law is control of stock and bond issues. The capitalization of utility companies is limited to the actual value of the property used in the public service. The reason for this requirement is obvious. Stock watering is always and everywhere an evil of far-reaching and especially baneful significance; but nowhere is it more mischievous than in the case of public service corporations. Wisconsin has abolished it, so far at least as public utilities are concerned. Besides, experience teaches us that to be effective public regulation must be complete. It cannot be complete without control of the issue of corporate securities. In determining what is adequate service or a just rate, account must be taken in every case of the value of the plant. The value here spoken of is of course the actual, true value. There is no reason in the world why with complete control this value should not correspond with the stock and bond value, taking these securities at par. If so, control will be facilitated, the interests of inexperienced investors safeguarded, and the utility placed on a stable and conservative basis.

No public utility operator in Wisconsin doubts in his heart that all honest utility companies of the state have been benefited by commission regulation. Unremunerative rates have been raised, unfair competition has been throttled, stockholders have been given a fair return on their investments, securities have been made sound.

What Wisconsin has done the other states can do. Those which as yet have no utility commissions are considering their formation. They will want to study the workings of present bodies of that nature before appointing their own. They could have no better model than the Wisconsin Railroad Commission.

CACTUS FOR TELEPHONE POLES.

Sahuara for telephone and telegraph poles is the latest idea and one that is to be tried out. It sounds plausible and it is believed that it will be more economical than the old style poles. Its test is to come from Tucson, Arizona.

The government is to build a telephone system for the forestry service of the Coronado forest reserve. The first of these lines to be built out of Tucson is to be used into the Catalinas, and it is there that the sahuara experiment is to be tried.

The giant cacti will not be sawed off and set up nor will they be transplanted, but the growing plant will be used as a pole where it is found practical. Where they can be found in what approaches alignment, so that the line will not have to zigzag too much, the sahuara up in the canons through which the line will pass are to be utilized for the purpose of attaching brackets to which the wires will be fastened.

Along the proposed line it is difficult to set poles, owing to the rocky nature of the country traversed. Not only is this the case, but it is difficult to get the poles up there in the hills to set, while the sahuaras are right there in many instances, and while not of a uniform distance this is not considered important. Another saving will be that while the-made-to-order poles will not oust the ready-made ones, these will be of long life and will not demand replacement and replacing from time to time.

TRIPOLI HAS SEVEN TELEPHONES.

The city of Tripoli, with a population of 40,000 has the only telephone exchange in the entire district of Tripolitania. It has seven stations and is operated by the military department, either at the military or civic offices of the Turkish government. The system has the common battery type of switchboard and was installed by the Societe Industrielle des Telephones of Paris about a year ago. The line to the Ottoman post has been discontinued, and the one to the police station will soon be, leaving only five in service. As yet there are no plans for additional installation in the near future. Benghazi and Misurata, towns having a population of over 10,000 have no telephone service, as it would not pay. The country has 3,150 miles of telegraph.

Telephone Testing and Fault Location

Non-Technical Trouble Cures

SIMPLE TESTS.

FAULT location is, as the term indicates, a quantitative test. That is, the test not only demonstrates that there is a fault, but it determines the precise point on the line which is faulty. For this work instruments of some delicacy and precision are required, as well as a knowledge of how to use them. The determination of the existence of certain conditions, as crosses, grounds and opens, on the other hand, involves only rough tests, such as may be made with a battery and receiver or a magneto and bell.

The simplest testing set of the qualitative order is a strong magneto generator, which will ring a bell through a high resistance—say from 25,000 to 75,000 ohms. The generator and bell are mounted in a small portable case, together with a telephone receiver, which may also be used as a magnetic transmitter. A simple galvanometer, or rather galvanoscope, since it is used to detect and not to measure current—may well be added to the outfit.

Testing with such an outfit is as simple as the apparatus itself. If a ground is suspected on cable or open wire, the far end of the line is opened and the magneto and bell connected from the near end to ground. The ringing of the bell, of course, shows a circuit. Presumably this circuit is completed through a ground fault on the line. On long lines, however,

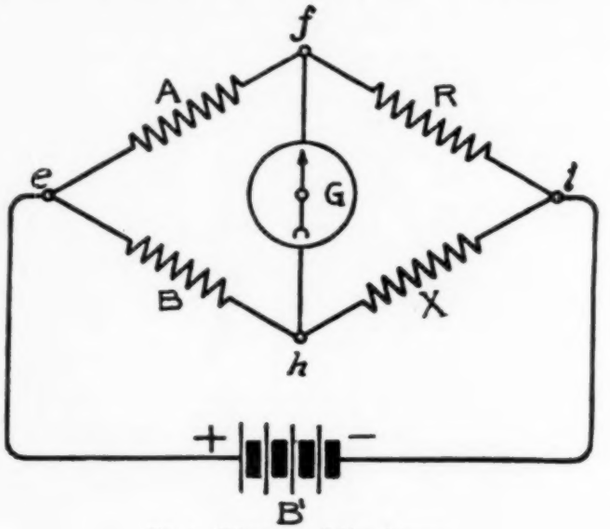


Fig. 1. Wheatstone Bridge Diagram.

there is always the possibility that the line and the nearest neighboring conductor may form the two sides of a condenser whose capacity is great enough to ring through. On short lines this condition does not exist, and the bell ringing positively signifies a ground on the line.

On long lines, therefore, a direct current is more useful as a testing medium than the alternating current of the magneto generator. The galvanometer and battery may be substituted for the generator and bell. A *permanent* deflection of the galvanometer needle indicates a ground on the line. A momentary kick of the needle and its return to zero merely indicates capacity, the condenser effect noted before, and should be disregarded.

To test for a cross between two or more wires in a cable or lead, one of the suspected lines is connected to the magneto bell or the galvanometer and battery,

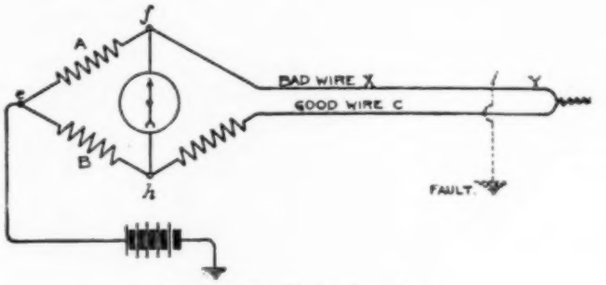


Fig. 2. The Varley Loop Test.

the other terminal of the apparatus being connected to *all* the other lines at once. The test will then be similar to the ground test.

An open, of course, will show no current transmission, either to ground or when the far end of the line is grounded.

Another simple test is made with a head receiver and two or three cells of battery. The connections are the same as with the magneto or galvanometer, except that the wire from the receiver is not fastened to the end of the line, but they are touched together at short intervals. The first touch will produce a click in the receiver, on account of the capacity, the current passing into the line to charge it statically. Subsequent touches should bring no click. Clicks indicate grounds or crosses, as the case may be. Faint clicks indicate leakage or moisture. By grounding the far end of the line, tests for opens may be made in the same way, except that in this case the series of clicks indicate continuity, and failure to click indicates an open.

FAULT LOCATION.

The quantitative testing of telephone lines, that is, the exact location of faults, depends upon the use of the Wheatstone bridge principle, the fall of potential, or direct galvanometer measurements. For general resistance measurements, upon which depends the location of crosses, grounds, or opens, the Wheatstone bridge is very convenient. It is named after Sir Charles Wheatstone, who developed it.

As the name indicates, the bridge depends upon a closed battery circuit, across the approximate center of which is bridged a galvanometer. So long as the galvanometer is across the exact electrical center of the circuit—that is, so long as the resistances on both sides of it are equal—its needle will point to zero. So by putting an unknown resistance on one side of the instrument, we can add known resistance to the other

side until we read zero. The unknown and the known resistances will then be equal.

Fig. 1 shows the scheme of the Wheatstone bridge. Current from the battery B' divides at e into two circuits or paths, $a\ f\ r$ and $B\ h\ x$. The paths reunite at i. A, B, R and X are the arms of the bridge. Of these R is the rheostat, or variable known resistance, and X is the unknown resistance. In practice, of course, X is open, with two terminals for connecting in the resistance to be measured. Changes in the resistance of the battery circuit, e, i, or of the galvanometer circuit, f, h, do not affect the values of the bridge arms. The positions of the battery and the galvanometer in the scheme of the bridge may be transposed without effect. The bridge is balanced and the needle shows no deflection when

$$\frac{A}{X} = \frac{B}{R}$$

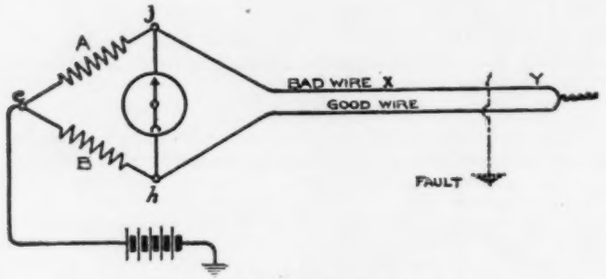


Fig. 3. The Murray Loop Test.

Two tests commonly used with the Wheatstone bridge are the Varley and Murray loop tests. They derive the name "loop" from the fact that in using them the far ends of the faulty line and a neighboring good line are connected together. The near ends of the faulty and good lines are then connected into the bridge circuit as shown in Fig. 2 for the Varley loop. The circuit is completed through ground from the fault to battery. Thus we have a connection to the faulty line on both sides of the fault, while the fault itself is connected to battery, thereby corresponding to the point i of the Wheatstone bridge diagram, Fig. 1. The arm R of the bridge comprises the known resistance R plus the resistance of the faulty wire to the ground. The bridge arm corresponding to X, Fig. 1, comprises the resistance of the good wire plus the resistance of the bad wire beyond the fault.

It is presumed that the good and bad wires are alike; which is the usual condition under which such a test is made. The bridge arms are also equal. Then the rheostat is adjusted until the galvanometer deflection is the least possible. The resistance of the rheostat divided by two then gives the resistance of the bad wire from the fault to the *far* end. This is usually sufficient information. If the resistance from the near end to the fault is desired, it is easily obtained, as the resistance of the good wire is known.

The Murray loop test is somewhat similar to the Varley. A standard resistance box and galvanometer are necessary. Fig. 3 shows how they are connected. Resistances A and B are both adjustable. The bad and good wires are bridged across the galvanometer, as the figure shows. A balance being obtained by adjusting A and B until the galvanometer points to zero, the following conditions obtain:

$$\frac{G}{B} = \frac{Z}{C+Y}$$

using the letters as in the Varley test just described. Then

$$\frac{A}{B} = \frac{L}{L-X}$$

and

$$X = \frac{A\ L}{A+B}$$

The resistance of the fault itself has no effect upon the value of X, in either the Varley or Murray loop tests.

It is often desirable, however, to find the resistance of a ground connection. A poor ground will cause trouble that is not always immediately traced to its true source. In measuring ground resistance a calibrated galvanometer or a voltmeter is used. A wire of known resistance is connected to the ground to be measured. With the rheostat at no resistance and the battery key open, the average mean deflection produced by the earth current is read. Positive battery is then connected to line and R adjusted until the same deflection is read. The rheostat resistance we will call **X**. Negative battery is then connected to line, and R again adjusted to the same deflection. This rheostat resistance we will call Y. Then $2\ \frac{X\ Y}{X+Y} =$ the resistance of the two ground connections plus the line resistance. The line resistance being known and the near ground being nothing. Simple subtraction gives the resistance of the far ground. Fig. 4 shows the connections.

GALVANOMETERS.

In all but one of the tests so far described the galvanometer used has been little more than a current detecter, deflection values not being considered. For such use a comparatively simple instrument is required, consisting merely of a magnetic needle sus-

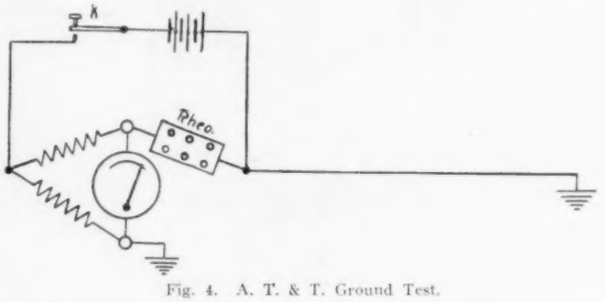


Fig. 4. A. T. & T. Ground Test.

pended or pivoted to swing freely in a horizontal plane, and normally maintained at zero either by the earth's magnetism or by an auxiliary magnet. When current is passed through a coil of wire surrounding the needle it is caused by electro-magnetic action to attempt to place itself at right angles to the wires of the coil. Its resulting position is a balance between the two forces, and the extent of its deflection depends on the strength of current in the coil.

This is sometimes varied by using a stationary permanent magnet instead of the movable needle, and suspending the coil between the poles of the magnet. In this case the indicator fastened to the coil is maintained normally at zero by the tortional elasticity of its suspension.

For exact measurements of insulation and capacity, however, sensitive instruments are needed, and the mere uncalculated action of a current and a magnet will not suffice. The types of galvanometers most frequently used in quantitative work are the Thomson and the d'Arsonval.

The Thomson galvanometer, while made in a number of different forms, consists in principle of a number of minute permanent magnets attached to the back of a small round mirror which is suspended inside of a coil of fine wire by an almost invisible fibre of silk or quartz. A ray of light is directed onto the surface of the mirror, and the beam of light reflected from it plays upon a graduated scale. It is exceedingly sensitive—too sensitive, in fact, to outside disturbances to make a satisfactory portable instrument. It is therefore used mostly in laboratory work, the d'Arsonval type being preferable for portable work.

The d'Arsonval galvanometer reverses the arrangement of the Thomson, comprising a suspended

Fig. 5. Portable Form of d'Arsonval Galvanometer.

coil in the field of a powerful permanent magnet. A small mirror is fastened to the coil. The mirror is used because it allows the use of a beam of light for an indicator; and as the light ray has no weight or inertia, the indicator may be as long as the desired sensitiveness of the instrument demands. Fig. 5 shows a popular form of d'Arsonval galvanometer.

A ray of light was mentioned as forming the indicating needle on both types of galvanometer. A more convenient method, however, is to mount a small telescope just above the scale so that on looking through the telescope the scale is seen reflected in the small mirror on the needle or coil of the galvanometer. It is obvious that as the mirror turns, the reflected scale

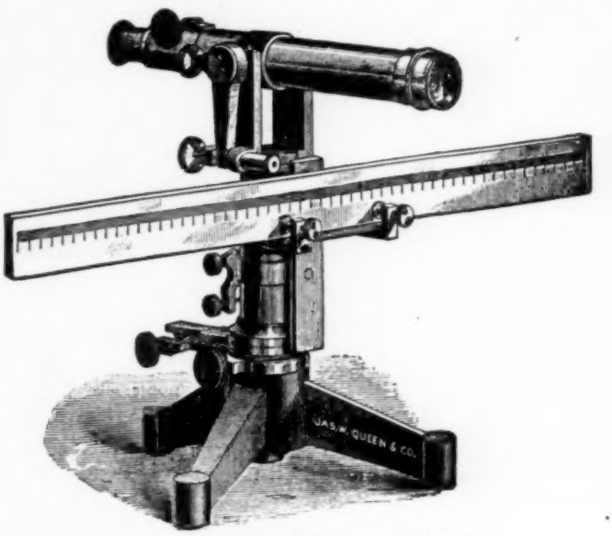


Fig. 6. Galvanometer Scale and Telescope.

will travel to the right or left, as the case may be. The arrangement of scale and telescope are shown in Fig. 6.

Galvanometers such as those just described are very sensitive, and sometimes the current being measured is strong enough to turn the indicator clear beyond the scale. In this case a known resistance, called a shunt, is bridged across the terminals of the galvanometer, so that only a definite and known portion of the current passes through the instrument. This ratio being known, the total current is readily calculated. For example, a shunt having 1/9 the resistance of the galvanometer would take nine times as much current, or 9/10 of all the current. The galvanometer current would therefore be 1/10 the total current.

The deflection on the scale of a reflecting galvanometer is practically proportional to the amount of current flowing, and so inversely proportional to the total resistance of the circuit. When the E. M. F. (voltage) is known the deflections obtained through known and unknown resistances are inversely proportional to the resistances. It is customary to work out a standard or working constant by reading the deflection with a known resistance and then calculating the hypothetical deflection through a resistance of one megohm. All other deflections in measuring resistances are compared to this constant.

INSULATION AND CAPACITY TESTS.

The insulation test is, of course, a resistance test. The total insulation of a line is equal to the parallel resistance of all the leakage points in its length. Where the insulation of a line is uniform, the insulation resistance decreases in proportion to the length of the line. The unit of resistance being the ohm, the unit of insulation resistance is one thousand ohms, or the megohm.

It has already been pointed out that the working constant calculated for the galvanometer was the deflection with a known E. M. F. through one megohm. We are ready, therefore, to calculate insulation resistances with little trouble. The galvanometer and standard battery are connected, one terminal to the line whose insulation is to be tested, the other terminal to a neighboring line, to the cable sheath, or to ground, according to which way the insulation is to be tested.

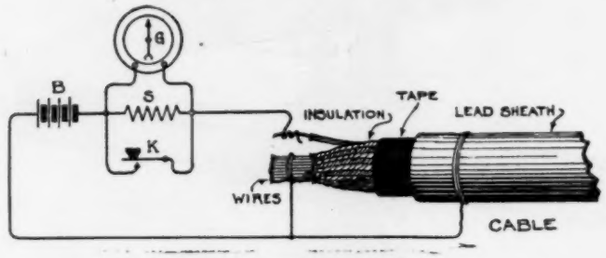


Fig. 7. Arrangement for Capacity Test.

The galvanometer is shunted out momentarily to prevent the violent kick of the static charge due to capacity. Then the *permanent* deflection of the galvanometer is divided *into* the working constant of the instrument, as previously determined. The result is the insulation resistance in megohms.

The connections should stand for a full minute before the reading is taken, to allow the static charge to reach its maximum by permeating to surfaces of the insulation.

In several tests so far described the momentary deflection due to static charge (or discharge) has been mentioned. This "kick" of the needle, previously disregarded, is the indication we use in the measurement of capacity.

As in resistance and insulation tests, the capacity test is made by comparing an unknown quantity with a known or standard quantity. In this case the known quantity is a standard condenser of known capacity. The process is simple. The standard condenser is charged by connection with a battery of known potential and is then discharged through the galvanometer by means of the key shown in Fig. 7. The galvanometer deflection being noted, the condenser is then removed and the line substituted whose capacity is to be tested. The difference in capacity is directly proportional to the difference in deflection. It is usual to use a two-pole, two-point switch in the testing circuit so that the line may be substituted for the condenser conveniently. The battery key should always be released suddenly. An adjustable standard condenser is often used to allow of a closer approximation to the line capacity. A quarter of a minute should be allowed to bring the line to its full static charge.

PORTABLE TESTING SETS.

In telephone and telegraph work, line testing most frequently has to be done at points comparatively remote from the central office. As a consequence, various types of portable testing sets have been placed on the market by different makers. These sets are, as a rule, constructed on the Wheatstone bridge principle and using the scheme of connections shown diagrammatically in Fig. 1.

The telegraph department of the British post office originated the portable tetsing set known as the "post-office set." For measuring resistances and locating faults it is very convenient. The connections may be traced in the diagram, Fig. 8. As will be seen, the rheostat arm is adjustable from 1 to 4,000 ohms; the bridge arms may be arranged to have 1, 10 or 100 ohms on one side and 10, 100 or 1,000 ohms on the other. The two arms are reversible in their relations by means of the commutator, *X, B, G, R*. The battery used consists of several small dry cells mounted in a block; or outside battery may be used.

The following data is provided by the Leeds and Northrup Company for a set of the "post-office" type manufactured by it:

The range and accuracy of measurements which may be made with it are shown in the following table:

	Probable Accuracy of Measurement.	
Resistance	Grade B	Grade A
.01 ohm	2%	2%
.1 ohm to 50,000 ohms	1/4 of 1%	1/8 of 1%
100,000 ohms	1/4 of 1%	1/5 of 1%
1,000,000 ohms	2%	2%

The theoretical range of the set is from .001 ohm to 11,110,000 ohms, and measurements can be made throughout this range; however, below .01 ohm or above 1,000,000 ohms, the accuracy falls off rapidly.

The set consists of a Wheatstone bridge, rheostat, battery, galvanometer and keys, all mounted in a wood carrying case.

The bridge has three coils in each arm, 1, 10 and 100 ohms in one and 10, 100 and 1,000 ohms in the other. The two arms are reversible and are adjusted to an accuracy of 1/10 of 1 per cent in Grade B and 1/20 of 1 per cent in Grade A. The temperature coefficient of the wire is such that ordinary changes of temperature do not decrease the accuracy. The rheostat consists of the following series of coils, 1, 2, 3, 4, 10, 20, 30, 40, 100, 200, 300, 400, 1,000, 2,000, 3,000, and 4,000 ohms. They are adjusted to an accuracy of 1/5 of 1 per cent in Grade B and 1/10 of 1 per cent in Grade A. The blocks are mounted on polished hard

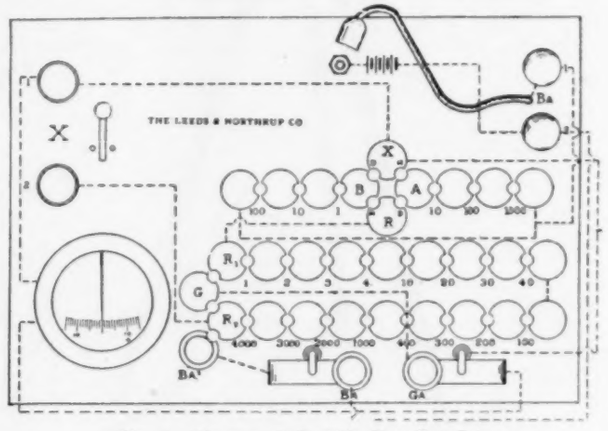


Fig. 8. Diagram of Portable Postoffice Set.

rubber and great care is taken to secure perfect fit of plugs.

The galvanometer is of the moving coil type and is so designed as to give a miximum sensibility, and at the same time to be dead beat and quick in action. It is constructed with sufficient strength to withstand the rough usage of shipment and continual transportation without danger of breakdown. Improvements in design and construction have attained a high sensibility,

and this is one of the essential points on which the range and accuracy of measurement depend.

Small dry cells are used, which have high voltage and low internal resistance. They are mounted in a block and can be replaced when exhausted. As they have good capacity and do not deteriorate when not used, renewals are seldom required. A pair of binding posts is provided so that outside battery may be used.

There is a key in both the battery and the galvanometer circuits, and these are conveniently placed on the front of the rubber plate.

The set is conveniently portable, measuring 6½ inches by 8 inches by 10½ inches and weighing 10 pounds.

The so-called "decade" type of instrument differs from the post-office type in that the desired resistances are obtained by inserting plugs, and but one plug is required for each iron of resistances; whereas the post-office instrument uses a plug for each unit, which is withdrawn when the resistances is needed. The scheme is shown diagrammatically in Fig. 9, and the description by the Leeds and Northrop Company is as follows:

The rheostat is arranged on the decade plan. This requires but a single plug for each row of resistances, which makes it very convenient to manipulate, and has the very decided advantage that the resistance is read off directly from the position of the plugs. As will be noted from the drawing, the blocks are in pairs, and each pair is mechanically independent of the other blocks. There is consequently no danger that a plug contact will be loosened by removing a plug near it. This is a trouble which must be guarded against in using rheostats having the 1, 2, 3, 4 arrangement, or the 1, 2, 2, 5 arrangement, by running over all the plugs to see that they are tightly in position just before making a measurement. On account

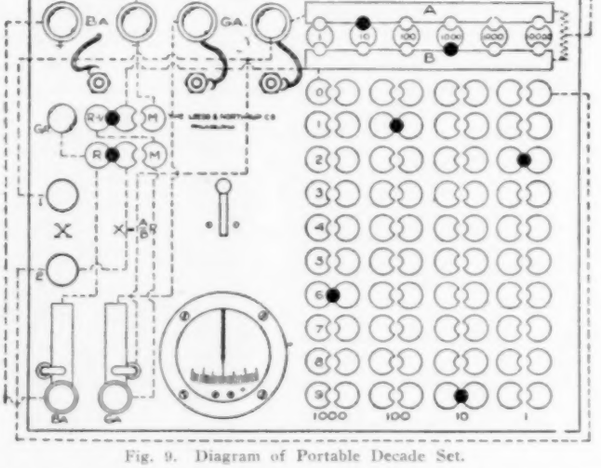


Fig. 9. Diagram of Portable Decade Set.

of the ample distance between the rows, there is no trouble in manipulating the plugs, even when the operator's hands become benumbed by cold or he has to wear gloves.

The ratio coils are arranged on the plug-in plan and are reversible.

Blocks are provided so that connections can be quickly made for locating faults by both the Murray and Varley loop tests.

Binding posts are provided so that an outside battery can be used, or an outside galvanometer, thus providing for the possibility of using more battery in case faults are to be located where there is a very high resistance in the fault, and also for the possibility of using a highly sensitive outside galvanometer in similar cases. The set contains four cells of battery, and a sensitive portable galvanometer, which will deflect one division with one volt through a resistance

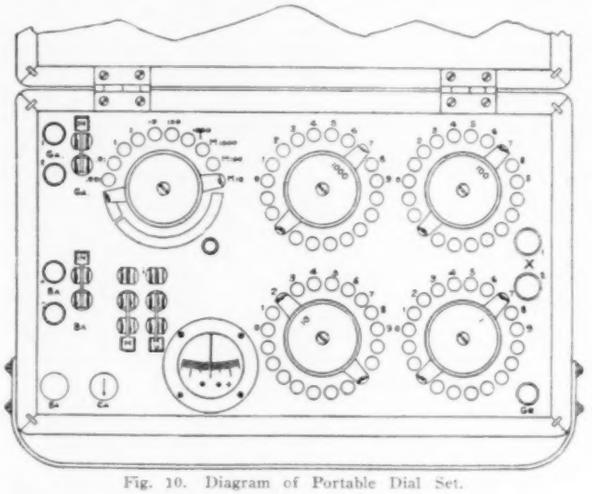


Fig. 10. Diagram of Portable Dial Set.

of about one-half megohm. The battery is ample and the galvanometer sufficiently sensitive to meet all ordinary requirements.

The method employed in the bridge arm arrangement avoids the use of a commutator, such as is used in the post-office type of bridge having reversible bridge arms, thereby eliminating the use of two extra plugs. Another decided advantage of this bridge coil arrangement is the fact that the formula for the unknown resistance is always $\frac{A}{B} R$ regardless as to whether a particular coil is used in the A arm or B arm. The bridge has six coils 1, 10, 100, 1,000, 1,000, 10,000 ohms which are adjusted to an accuracy of 1/20 per cent.

The rheostat has four decades with values of units, tens, hundreds and thousands, there being nine values in each. The accuracy of adjustment is 1/10 per cent. The coils are arranged upon a plan using but four coils to each decade. This plan is protected by patent.

Of late years there has been a demand for a type of instrument using some modern form of switch to replace the somewhat antiquated plug system. This has resulted in the development of the so-called dial set. A good example of such a set is the one made by the Thompson-Levering Company. This set is of the latest improved type of switch construction, and is adaptable to all tests in which the Wheatstone bridge conditions may be used.

The rheostat is composed of four dials of ten coils each. These dials have values of units, tens, hundreds and thousand ohm coils, which are guaranteed accurate to 1/10 of one per cent. The bridge arms A and B have values of 1, 10, 100 and 1,000 ohms in each arm, guaranteed accurate to 1/20 of one per cent. The accuracy of this adjustment makes the results as close

as are practicable, and the values of the arms give a very wide range of measurement.

The switches are of a special design, of the quick make and break style, allowing the tester to make changes rapidly in performing the different tests to be made, thus making it very easy to manipulate.

The rheostat dials have a special design of brush, which is entirely new, and which gives a uniform spring contact, both on the arm running over the blocks, and also on the center ring. The brush is

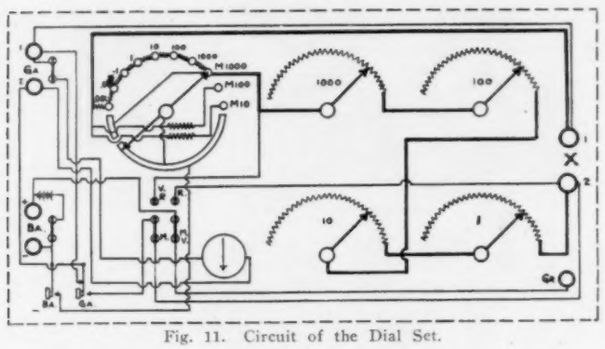


Fig. 11. Circuit of the Dial Set.

laminated with a number of laminations of spring phosphor bronze; the ends are carefully ground, and slide over the contacts evenly and smoothly, and the contact resistance is negligible. The brush is set at an angle, so that in swinging over the blocks, it does not mark or line the blocks. The contact surface on the center plug is equal to the contact surface on the stud, thus on all switches the contact surfaces are equal. There are no flexible leads or connections to these brushes, all connections being permanent and rigid, and the brush is so arranged that it swings in a complete circle in either direction, going from the highest value to the lowest value coil in any decade, without having to be turned back over the intermediate blocks.

In this set, as part of the apparatus, is an Ayrton shunt, allowing the use of full current, 1/10 part of current, or 1/100 parts of the current to flow through the galvanometer of the set, or the outside galvanometer, whichever is used with the bridge at the time, and provision is made, by a quick make and break switch, to use either inside or outside galvanometer. The galvanometer itself is of the d'Arsonval type, and has a very high sensibility. The magnet is made of special magnet steel, carefully aged, and is permanent and strong. The galvanometer is very quick and positive in its action, and the construction and design is such that it is extremely dead-beat, making readings very easily and quickly. The galvanometer key is arranged with a short circuit device, which also helps to bring the needle to rest promptly. The galvanometer scale has thirty millimeter divisions with center zero, is well lighted, and easily read, and the scale is uniform, making the set well adapted for insulation measurements.

The batteries in the case consist of four commercial size cells. These cells are replaceable by removing four small screws, which releases the cell block in which the new cells are put; this block is then slipped back into place and screwed in, the operation taking but a few minutes, and the rest of the set being entirely undisturbed.

The size, 9¼ inches long by 5¾ inches wide by 5½ inches deep, and the set complete, as taken out by the tester, weighs 7¾ pounds.

A diagram of a dial type set (one made by the Leeds and Northrop Company), is shown in Fig. 10, while Fig. 11 shows the circuit of the same instrument.

A form of Wheatstone bridge not previously is the slide-wire bridge. In this the arms A and B of the bridge (Fig. 1), are united in one straight resistance wire. Along this wire the point f slides as a movable contact. This will be understood by reference to Fig. 12. The functions of the parts of the regular bridge are reversed, in that the rheostat R is of fixed value, only the arms A B being adjustable. The continuous wire forming these arms is generally furnished with a scale divided into 1,000 parts. Then since $A + B = 1{,}000$, the ratio

$$\frac{A}{B} = \frac{A}{1{,}000 - A}$$

and the unknown resistance

$$X = \frac{A}{1{,}000 - A} R$$

It is customary to make the bridge wire forming the arms A B one meter in length. For the sake of portability it is divided into several shorter lengths, connected in series by metal blocks of no resistance. If desired, the scale may be calibrated directly in ohms, making the instrument an ohmmeter.

Another variation from the straight wire of the slide wire bridge is made by using a toroidally wound coil of resistance wire, forming a ring about six inches in diameter, with a rotary arm pivoted in its center. The arrangement is substantially the same as with a straight wire. Fig. 13 shows such an instrument diagrammatically.

Insulation and capacity testing sets are also made in portable form. A type of such sets is described as

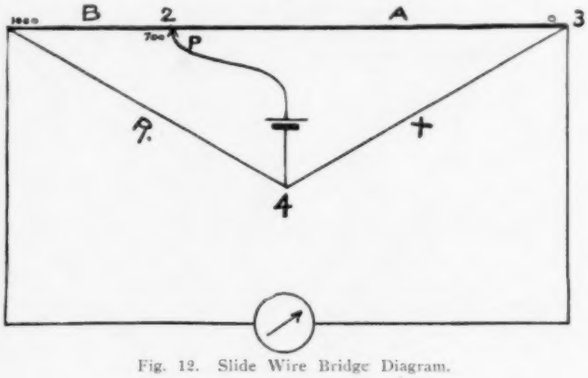


Fig. 12. Slide Wire Bridge Diagram.

follows by its makers, the Thompson-Levering Company:

The complete outfit consists of three units, the galvanometer and the test box complete in a carrying case, and the tripod.

The galvanometer is of a high sensibility type, having a sensibility of 1,000 megohms, or more if desired. It is composed of two units, the first being the magnet, and the second the tube with the coil system. Construction is such that the tube is easily removed.

The magnet is of special magnet steel, carefully aged and hardened, and is permanent and strong. It is insulated from earth by three leveling screws, highly insulated, and of a design which admits of rapid and easy adjustment.

The system is ballistic, and is provided with a removable damper, which can be placed on the coil, in order to make the system dead-beat. It is in its entirety visible through a glass window, which may be removed, and the system is readily accessible at all times for any adjustment desired, or for the putting in of new upper and lower suspensions. The design throughout is such as to admit of ease and rapidity in cleaning the entire galvanometer, and there are no parts where dust and dirt can collect, where it cannot be quickly removed.

The galvanometer coil is clamped by a special spring arrangement, operated by a screw on the back of the tube, which insures the coil being held rigidly during transit, and also being capable of being quickly and carefully released when it is to be used.

The contacts are made on pure silver, and they are made automatically when the tube is slipped into the pole pieces in place in the magnet.

The telescope arms are insulated from the magnet, and are supplied with a leveling screw to give the exact adjustment easily and readily.

The pole pieces are so designed that the instrument gives a deflection proportional to the current throughout the entire scale, thus giving a uniform sensibility.

The galvanometer lens system consists of an acromatic objective lens and acromatic Ramsden eye-piece. The objective is especially corrected for flatness of field. The eye-piece consists of two lenses, acromatic eye and single field.

The scale is a copper-plate reproduction of a standard millimeter scale, and is half red and one-half black, facilitating the deflection readings.

For adjusting the mirror on the scale there is on the galvanometer an arm fastened to the top on a tortion head, to which is attached two long arms. These arms will be insulated from the moving coil system, the object of the arms being to cause a finer adjustment than can be obtained on the *tube* in any other way. There is also supplied a rack and pinion on the *galvanometer scale*, so that still finer adjustment can be made, when desired.

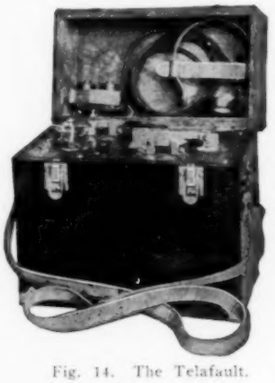


Fig. 14. The Telafault.

The test box is of oak, the top plate being of the best grade of hard rubber, upon which are mounted the individual instruments, making one unit. The hard rubber plate is 8 inches by 11 inches by 9/16 inch thick, and with the test box are supplied three legs, which fit into the bottom of the test box, to insulate it from earth. These legs are made of polished hard rubber rod.

The switches are one main test switch with studs marked "Cable" .1 megohm and .1 m. f.; one shunt switch with values of 1, 1, .01, .001.

Switches are constructed of spring phosphor bronze, and are of the laminated type, making contact on ground brass studs, and have a negligible contact resistance. Each of these switches has a special handle of hard rubber, of a design allowing ease of manipulation at all times.

The coils throughout this set are wound of manganin wire. They have been carefully seasoned and require no correction through very wide ranges of

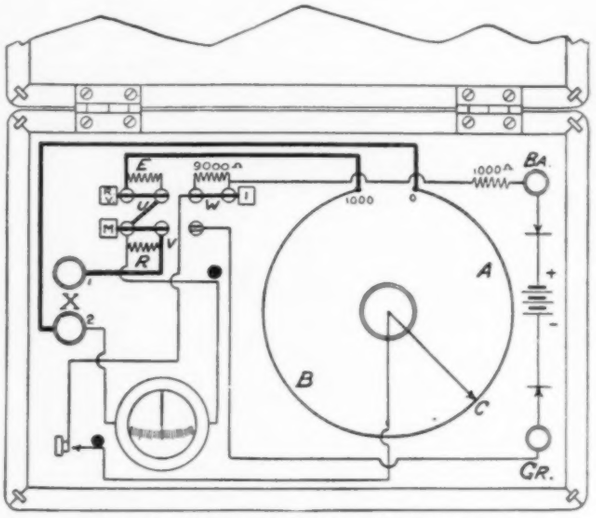


Fig. 13. Diagram of Portable Slide Wire Set.

temperature, the manganin wire being of zero temperature coefficient. They are adjusted to an accuracy of 1/25 of 1 per cent, and are highly insulated from the rubber plate and from the case, and are attached to the stud to which they are soldered.

The standard condenser is of .1 m. f. value, and is carefully and substantially mounted, and is accurate to ¼ of 1 per cent.

The special short circuit key is constructed so that the right end has a knife-blade contact, and the left end a spring contact, made on silver points. This spring is so arranged that the operator pressing the left side, automatically releases the right end contact, and completes the circuit on the left-hand side.

The insulation and capacity key is to the left of the short circuit key, and in convenient position to be operated by the index finger of the tester. This key also makes contact on pure silver points, which are of ample size and carefully ground, and have charge, insulate, and discharge points.

The insulation and capacity switch consists of a single pole double throw, finger type actuated switch, with knife-blade spring contact.

The cable posts are large and substantial, and have a switch attached, so that the cable can be quickly short circuited by closing this switch across the posts.

SPECIAL INSTRUMENTS.

In addition to the portable sets dependent upon the Wheatstone bridge principle there are on the market a number of testing devices whose operation is based upon certain discovered phenomena. Among these may be mentioned the Telafault, made by W. N. Matthews and Brother. The following description of the Telafault is by S. D. Levings:

The principle involved in the Matthews improved

Telafault is a new one. Briefly, the principle is that of sending out over one conductor a pulsating or low connected electrically to the ground or the other con- its return over another, connected to the former through some fault. It is obvious that a closed circuit can be established between a conductor and ground, or another conductor, provided such a conductor is connected electrically to the ground or the other con-

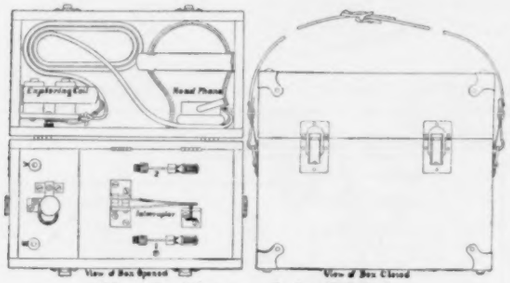


Fig. 15. Diagram of the Telafault.

ductor. The word "electrically" is used advisedly as, in common parlance, a ground or connection may or may not be metallic or physical. It may have a high or low resistance and form a connection only when charged with an electric current at a potential that will break down the resistance. If all troubles from grounds and short circuits were metallic, there would still be a wide field for the Telafault, but the uncertainty of conditions would not exist as in practice and the efficiency of the Telafault would not be as clearly recognized.

Having established a closed circuit through the conductor or conductors in trouble and a source of energy, it is evident that current sent out over one side of the line will return via the other, with more or less loss which is governed by the electrical efficiency of the circuit. If this be true, it can be said that beyond the point constituting the end of this closed circuit, no current will be detected. If some method of locating the circuit is at hand, which operates by the detection of the pulsating current with which the closed circuit is charged, it is clear that beyond the end of the circuit the detector will cease to respond to the charging current, and the end of the circuit will have become identified. As it is possible always so to make up the circuit as to place the ground or short circuit causing trouble at the end of the improvised closed circuit, any apparatus fulfilling the conditions in the proper manner will detect such an end, and therefore the trouble.

The detector of the Matthews Telafault operates on the principle of induction. The chief cause for failure in detection was found to be the interferences set up by stray currents existing on every cable system, from outside sources. A detector to be of value must be so designed that it will register only the induction produced by the known source of energy charging the closed circuit. Any other registration would, of course, have a tendency to confuse and destroy the accuracy of the test. The Matthews Telafault detector is so designed as to be non-sensitive to outside disturbances and sensitive to the current furnished by the vibrator which forms a part of the apparatus.

The chief use to which the Telafault can be put is the location of all manner of troubles, except opens, in power, telephone, telegraph, fire-alarm telegraph and other cables containing a number of conductors or pairs.

The telephone, telegraph and fire-alarm telegraph cable plants are totally different from the power cable plant. In each of these cases, spare conductors are provided in the cable to care for the contingencies of trouble and growth. The first two generally make use of paper insulated cable, while the latter invariably calls for rubber. Telephone and telegraph cables, commonly called dry core cables, are susceptible to more trouble than cables insulated with saturated paper, rubber or varnished cambric. Further, the troubles are more difficult of detection to the older methods.

The paper used in insulating such cables is of pure manila fibre and when around the conductor forms a loose covering for it. When all of the pairs are cabled,

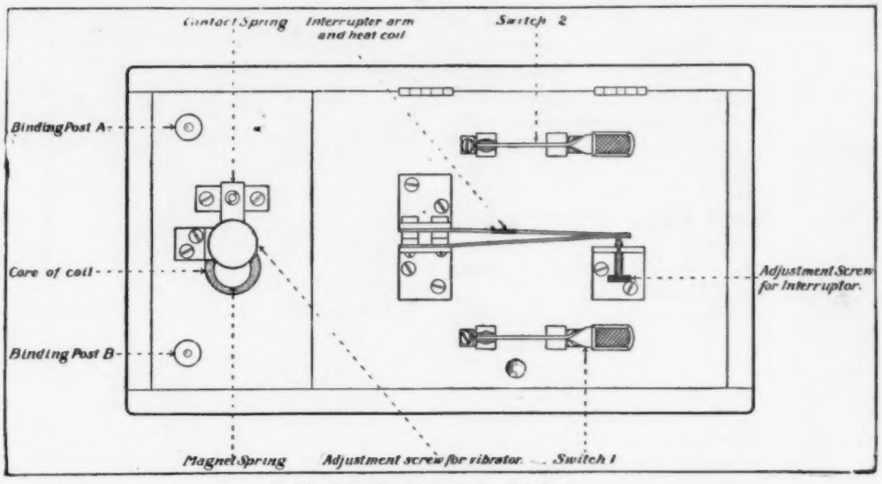


Fig. 16. Circuits of the Telafault.

the core, as it called, is placed in drying ovens, operating at a temperature of about 230 degrees F., and baked for a certain period of time. The core, while still hot, is passed through the lead press, and the sheath is formed around it. Two things are evident: the paper must be very dry and susceptible to the slightest moisture, and a slight vacuum must be created as the core cools within the lead sheath, introduc-

ing a further tendency for the cable to absorb moisture, should a chance be given it. Unquestionably the sheath is perfect when it leaves the manufacturer, as the cable is tested under water, but poor packing, rough transportation and handling in erection, may damage it to such an extent that it will admit moisture, when perhaps it will not admit water in liquid form. Such a cable is the Nemesis of the telephone man. There is no telling the exact effect such a trouble will produce. One day when the humidity is great, it may affect the working of one or more pairs, the next day, the cable may test absolutely free from grounds or crosses. It may spread along the core for as much as a span, or it may remain centralized within a very small area. The trouble may show an extremely high resistance to the passage of current, or it may appear metallic, and so on to an unlimited degree.

High resistance grounds, crosses or short circuits are difficult of location by the well known instrument methods. In underground or aerial paper cables of the above mentioned construction, which develop faults, the first proceeding is to determine the approximate location by means of the resistance, or Wheatstone bridge method, using the Varley, Murray or Fisher loops. When this has been determined, the trouble men should go to the proper manhole, if an underground cable, and proceed as in the case of the low tension power test, taking care, however, to test all lateral cables, as the trouble might lie in a leg, and not show beyond in the main cable as a consequence. The operations as described should be repeated until the trouble is located.

In the case of aerial cables, the terminals may be likened to the manholes of the underground system, and all tests made with reference to them as sectionalizing the line. When an approximate location has been obtained, the Telafault may be taken to the nearest terminal, there connected to the cable and the process of locating the trouble commenced. In all ordinary cases, it is preferable to ride the messenger, sliding the detector along as the cable man progresses. In some instances, however, messenger wires have so deteriorated by the action of the elements, as to make it hazardous to send a man out on them. In this case, the detector may be mounted on the end of a bamboo rod of sufficient length, and adjusted to slide along the cable, working from the ground.

Pinholes in the lead sheath are the greatest source of trouble in aerial cables that go "wet," producing high resistance grounds. These holes are generally so small as to defy detection by inspection. Bullet holes, cracks, etc., are sometimes quickly found and repaired by close inspection, but these cases are few, and do not represent the average of cable troubles.

The bridge or other instrument methods of fault location are at best approximate, and results showing an error of one-half of one per cent, in the average case, are considered accurate. In the case of a cable 5,000 feet in length, such an error would mean a possible location 25 feet from the true one. To cut into the cable at various points for this distance is certainly a method to be discouraged.

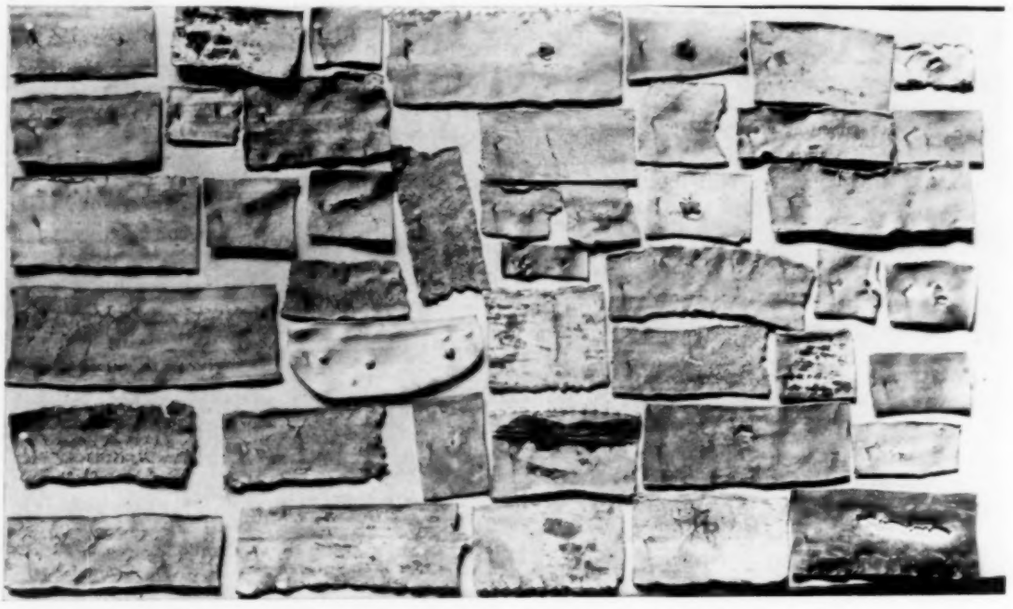


Fig. 17. Cable Sheath Sections, Showing Faults Located by the Wireless Tester.

The Telatault, while it will locate "dead shorts" and wet spots, has located high resistance crosses and grounds up to 50,000 ohms. It requires four ordinary dry batteries, and the instrument does not have to be taken out on the line. It is usually operated by the wire chief and a troubleman, who only has to take the head telephone and exploring coil with him. Its simplicity of operation and construction, absence of tables and technical formulae for use, place it within the grasp of non-technical men.

Figures 14, 15 and 16 show respectively the appearance of the Teletault, the diagram of its connections, and an enlarged circuit drawing showing the functions of the various parts.

Another special device which has come into considerable use, and has the advantage that it requires no technical knowledge whatever to operate it, is called the "wireless" cable tester. It is made by the

Electric Specialty Company. In September, 1900, a patent was granted by the U. S. Patent Office to Frederick T. Iddings and Dwight H. Washburn for an apparatus for locating trouble in an electric circuit. The apparatus consisted of a means of producing a current in a circuit, and then tracing the circuit by means of an exploring coil and a telephone receiver. The patent was assigned to Dwight H. Washburn, who died before getting the device in shape to put on the market. After the patent was granted, and the circuits and apparatus published in the usual manner, it came to the notice of some party or parties, who evidently thought they could realize some money by selling the idea to others who did not know of such a method of testing. This it is quite probable they did, as it seems not a few were familiar with the idea.

The apparatus to be used, however, was very simple and only practical in a small per cent of actual trouble. It remained for George A. Bishton, wire chief, and J. E. Matteson, cable man for the Cedar Rapids and Marion Telephone Company at Cedar Rapids, Iowa, to perfect the induction cable tester that has proven so satisfactory to hundreds of telephone, telegraph and electric companies.

After Mr. Bishton and Mr. Matteson perfected their tester, they applied for both United States and Canada patents, and also bought the original patent from the widow of Mr. Washburn, thus securing the basic patent in addition to the improvements which they perfected.

Figure 17 is from a photograph of forty-four pieces of cable sheath, each an actual cause of trouble in one exchange, and located with a wireless cable tester during the past few weeks. This trouble was all caused by moisture, or where the wires were in direct contact with the cable sheath, because of lightning, bullets, etc.

Many other troubles were found during the same time where the cable wires were shortened or crossed leaving no indication whatever on the sheath; these troubles were as easily found as the grounds.

A recent improvement in the Wireless permitting the use of a 20-volt battery, has proven a great help in locating shorted pairs.

Telephone Herald in Operation

By order of the Public Utilities Commission of New Jersey, which became operative September 7, the New York Telephone Company was directed to furnish leased wires to the New Jersey Telephone Herald Company.

The latter company announced through its counsel, Albert A. Wray, that by October 1 it expected to be able to furnish Newark, and later other towns and cities throughout New Jersey, with a telephone news service modeled after the Telefon Hirmonde, of Budapest, Hungary.

For nearly a year the New Jersey Telephone-Herald Company has been negotiating with the New York Telephone Company for leased wires, but the telephone company officials feared that by leasing its wires to such a corporation it might be invalidating its franchise rights. The Telephone-Herald Company, through Albert A. Wray, Edward Kenney, the speaker of the New Jersey assembly, and George W. W. Porter, of Newark, took the matter before the Public Utilities Commission, with the claim that their company was not a public utility corporation, but that as a business corporation it would be unjustly discriminated against by the New York Telephone Company if that company refused to lease wires to it, when it had previously elected to lease wires to stock ticker, burglar-alarm, fire-alarm and kindred private business corporations.

Charles T. Russell, general counsel, and T. P. Sylvan and C. Walter Artz, as associate counsel, represented the New York Telephone Company before the Public Utility Board, whose order was based chiefly upon the petitioner's contention that without such order it would be unjustly discriminated against.

The New Jersey Telephone-Herald Company proposes to furnish to its subscribers a daily service which will run from 8 o'clock in the morning until one hour after midnight, and, according to its announcement yesterday, its working organization has been built up pending the outcome of the question at issue with the telephone company. It expects to give its subscribers a bulletin review of the news between 8 and 9 o'clock in the morning. The advertising page of this "talking newspaper" will be read to subscribers from 9 to 9:30, and from that hour up to 10 o'clock the schedule calls for local personals and small items.

Stock quotations, incidental news which develops during the day, foreign dispatches and an afternoon program of orchestra music fill up the day's schedule until the scores of the baseball games come along in the evening.

Operas and other musical offerings are planned for the evening hours, with an after concert of orchestra music running from 11 p. m. to 1 a. m., and during any of these hours while the service is on important news dispatches have the call for momentary interruptions.

The Telefon-Hirmonde, of Budapest, has been in use in that city for a number of years, and according to the American promoters has been a practical success. The United States Telephone-Herald Company holds the American rights to this Hungarian invention, and the New Jersey company, which announced the start of actual service yesterday, holds a subsidiary right for that state.

News bulletins, advertising, stock quotations and such matters will be handled by the company's employees from the Essex building, in Newark, while the music and Sunday sermons of noted preachers and public affairs of that nature will be conveyed to the subscribers through microphones placed in the halls, theaters or rooms where the performance is going on.

Subscribers will not hear any sound from the instrument unless they put the receivers to the ear, except in the case of bulletins of news of world-wide interest, when a buzzer will call their attention to the fact that such news is about to be told. The instrument is so designed that no one can talk into it and be heard, except from the central office or from the places where the microphones are placed. So far as the subscribers are concerned, it is a "listening service" only.

Captain William E. Gunn, of Newark, is the president of the New Jersey corporation.

The British post-office has decided to build a cable from Holyhead to Ireland, 56 miles long. This will be the longest submarine telephone cable in the world.

What One Woman Thinks

By Sarah Elizabeth Brown

HERE we are again, with business all shot to pieces. Month in and month out, ever since the little spurt early in the year, we have had the same story. Men who should know better look us in the eyes and say there will be nothing doing until after the next presidential election. They got that idea from their grandfathers.

The conditions in the country are sound. All outward indications point to a resumption of business activities right now. The season's crops have been good. The fruit crop was never better, and fruit is the farmer's luxury. The balance of trade between this and other countries is largely in our favor, and the banks are lousy with money.

To be true, that frightful stock list hasn't been fixed yet, but they are doing things to it in the rough and tumble way. But Mr. Man, have you run your eye up and down the this and last year's columns to see how telephone weathers the storm? Isn't it worth something to know that our game is of the par excellent sort? It is to me.

To save my life I can't see what will ever shake telephone securities. Every piece of apparatus that goes into a system has a larger intrinsic value than we are asked to pay for it. I can't understand how a manufacturer can turn it out for the price. Maybe he can't and hasn't found it out yet. And I am one of those dreamers who anticipates the ultimate scrapping of every item of the plant, to be succeeded by something vastly more efficient. What difference will it make? Not a bit. Telephone business is public service. The public has paid for all this apparatus; all the labor of installing and operating, and a profit on top. The sweeping out of plant for a superior method would be at the insistence of the public, and peculiar as it may sound, they wouldn't care a rap what it cost. This thing has been proven so many times that I feel it a waste of time to carry on the subject.

However, the country doesn't respond to the thing we call normal business. The "big interests" seem gleeful over the court's construction of the anti-trust law in spite of the fact that the government is persisting in its prosecution. President Taft is chasing around the country, imposing his cherubic smile upon the populace—explaining that he is as big as he looks and having a tough time in getting away with it. He finds the people courteous enough to see and hear him, but too busy with their own affairs to consider him seriously. The country is all right—the telephone business from the operator's point of view is a cinch. If we don't want to make our own extensions that's our business. Possibly we want to sell and get out—some more of *our* business, but none of yours, so there!

* * *

Some kind friend mailed a copy of the *Bell Telephone News* to me. I will take it seriously, for my hair is done up in curl papers, my sleeves rolled up as high as they'll go, and my arms stick to the oilcloth on the kitchen table. I can't be frivolous. I wonder how big an edition the *News* has? It looks like it cost a lot of money. There are 32 pages and a cover and only one advertisement—Old Mamma A. T. & T. of Boston. On the front cover is Hendrick's conception of a crossing policeman—a Milwaukee traffic cop. What's the significance? He is a blue bully, all right, if that is what is meant. He's a big-bellied, loppy-jowled husk with a fan in his hand—the kind they photograph presidents with. He's a harmless mountain of booze-saturated meat. I don't know why he should stand there as a representative of the law. He is plastered over with the Bell's trademark, but that doesn't afford him any protection and he needs it, or a drink, I don't know which. He needs something—maybe a push in the face, for he don't belong to the telephone business.

There are pictures of some mighty handsome and modest men—the big noises of the Central group—and an article or two that might interest telephone men who don't know the difference between plant and telephone engineering, and an editorial defending prepayment service. Pussy cat, this nickel-first thing isn't telephone service at all. When I visited my sister in Chicago in July, she had one of those tick-tock things in her house all the time and a nickel only part of the time. Her bills before the hold-up instrument was installed exceeded $3 a month. She has to pay $1.50 now, but she never will have 30 nickels in the box if the collector comes regularly. Sis has a baby and there are times when it is important for her to make calls, but the nickel is never handy. You can't train a woman to lay in a stock of five-cent pieces, or prevail upon her to use slugs. Her intentions may be good, but the little hoard of nickels are raided for the ice man or the paper collector or the other children filch them. Slugs mean the digging up of the whole amount in cash when the collector comes, and not being money the tendency is to use more of them. Your neighbors find them convenient, too, so they are tabooed. The nickel-first service is straight hoggishness. I don't believe the dear American woman will warm up to the "sensible, superior service." Put the telephone on a meter and measure the time the receiver is off the hook and charge accordingly. That's the candy! But how I do wander around. Oh, yes, then there is the little newsy stuff and how to drive a trouble wagon, when nearly everybody uses automobiles. And the picnics and ball teams. Well, I'm in favor of boosting the help to every good thing; their comfort goes far in promoting service, and service is the whole answer. I'm thinking, though, that the *News* is an expensive hand-out; that the same object might be attained by some other method. The *News* is interesting only to those people who are identified with a single operating company. It is not a telephone paper. A telephone paper should be interesting to all telephone people, whether employee, employer or investor. There is a lot of stuff in the *News*, the like of which I never saw before, and I'm sure there is a lot of matter in other telephone papers that would look well in the *News*. What

a dream of a paper we might have if the whole business could be covered to the satisfaction of everybody!

* * *

Ed Martin has sold all his toll lines to the Iowa Telephone Company. Ed Martin has won again. Here we have the real comedian of the telephone business putting it over his way. Martin got into the independent camp when it was in its swaddling clothes. He built up a great system in and around Webster City. He taught the farmers out there that he knew more about the telephone business than they did. If they were inclined to doubt it he would take their notes and lend them money to blow their heads off. Martin says he is going to quit the game—going back to the soil—join his boys on his Arizona range. Well, well, the Iowa conventions will be lonesome without Ed Martin's side show. Here's luck.

* * *

Remember Henry Fisk, the old Fisk-Newhall Fisk? Pretty nearly forgot him, didn't you? Well, he's been at Watseka, Ill., for ages, it seems, building up a system. It got to be such a dandy little affair that the Central Union picked it up. Henry Fisk will get back into the manufacturing business. You would have a tough time convincing him that the telephone business isn't worth following.

* * *

Here's my old friend, the National Telephone Company of Wheeling, teasing to have its receivership lifted. Can you beat it? My brothers, I may be an addle-pated, feeble-minded old woman who hasn't much thought other than that the telephone will stand nineteen hundred kinds of mistreatment and survive, but when the National can come back I've offered the real test. No other examples ever need be offered. It is hard to believe that this prayer to the court is on the level. I'm thinking there is a rat or two in the records and somebody wants to do some airing. Oh, very well, let the National come back. Let's have a lot of fun while we go along.

* * *

They are beginning to talk reorganization of the Illinois Tunnel Company. The last pretentious thing pulled off by the Tunnel Company was an answer to its prayer when the court permitted the receiver to issue $3,500,000 six per cent certificates. This money was used to put in automatic telephones in Chicago. These certificates must be redeemed next April. Right thinking people know that 20,000 telephones cannot earn three and a half million dollars in a year. I'm a fan on the goodness of the good, but I'm ready to throw up the sponge when the squeeze comes that fast. It simply can't be done. Of course, the people who took over those receiver's certificates knew that something must follow, so they just shut both eyes and trusted in the Lord. Now we get the rumble of the reorganization. No definite conclusions have been reached, but the negotiations have shifted to a new base of operation. They will pull off the next skirmish down East. It will be in charge of an eastern committee, who hint that the next move will contemplate a general first mortgage bond issue—a blanket proposition to be spread all over the automatic system, the warehouses, franchises, subsidies, etc., to an amount of, oh, say, twenty-five or fifty millions or so—mere bagatelle. Only five or six millions will be issued right away—enough to pay off those maturing receiver's certificates.

Do you know, I think I'll go crazy before I can dope these big easy-money layouts. Who buys all these securities, anyway? I go broke and a receiver gets me. I need some money and the court says to the receiver here's my order to go fetch. I find the money by legerdemain. The certificates come due and I mortgage the stuff. I've bought with my certificates and then sell the bonds. Pretty soon, if I'm lucky, I can pay the interest on the bonds. If I can't, maybe I can sell some more of them. After a time, I can retire a bond or two, or issue some second mortgage bonds and retire everything! Who puts up the money? I don't believe there ever was so much juggling of securities—so much real money put into a proposition so far removed from earnings as the Chicago Subway and the Tunnel enterprises. It never has paid and I'm wondering what generation of our children's children will succeed in making it pay. Somebody should erect a monument to the genius who solves these problems. No one will deny that millions of money has gone into the bores under Chicago and the competing system that has been installed, but on the other hand no one will deny that that money is a long time out of hand and that it will be a long time getting back. The funny part of it is the reorganization scheme says the telephone development is relied upon to pull the whole thing through! So there you are, you sweet little dingus with the dial on your base, spin around and show 'em you can do it. And you can, little one, if they give you time, but goodness knows, that's the roughest package that was ever slipped over your mouthpiece. Think of it, forty-five miles of concrete tubes, an electric railway system and Grant Park all saddled upon the telephone business. Don't tell me that competition hasn't its drawbacks.

Telephones in Paraguay

Consul Cornelius Ferris, Jr., Asuncion, says Asuncion is the only city in Paraguay having a telephone exchange. The total number of stations is at present 450, one for each subscriber. There are no stations other than the telephone instruments for each individual subscriber. There are no public call offices. The total length of exchange telephone wire in use and in reserve is about 300 miles. The length of toll or interurban wire is 88 miles. There are no telephone stations, such as branch stations for the police department. But one rate is charged for telephone service, viz, from $3.65 to $3.75 gold per month, the variation being due to the daily fluctuation in the value of the money of the country. Special agreements are made for service extending beyond the city.

The Judge—Can you describe any specific act of cruelty on the part of your husband.

The Complainant—I should say I can. Whenever he had anything to say to me, he'd call me up on the telephone and say it, and then disconnect before I had a chance to talk back to him.—*Chicago News.*

Lawyer—Now, what did you and the defendant talk about?

Witness—Oi t'ink about 15 minutes.

Lawyer—No, no! I mean what did you talk over?

Witness—We talked over the tiliphone.

The Telephone Scrap Book

Receiver as a High Frequency Generator

THE use of a telephone receiver as a generator of high frequency current is described in a recent number of *Elektrotechnische Zeitschrift* by Prof. A. Larsen.

It is well known that a telephone receiver will emit a sound when it is connected to a microphone through a transformer, as shown in Fig. 1. The vibra-

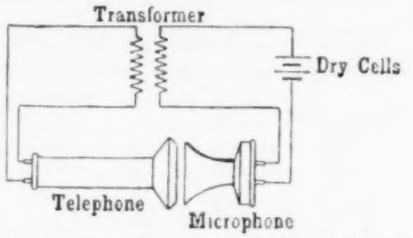


Fig. 1. Connection Between Telephone and Mictophone.

tion is, however, rather unstable; a slight change in the relative positions alters the pitch of the note considerably. The author had occasion to carry out certain tests with regard to the vibration of the membrane of a telephone receiver, and was surprised to find that these vibrations depend on the columns of air which are set in motion. The idea, therefore, suggested itself that the above-mentioned humming telephone might be controlled by adjusting the volume of air that was set in vibration, and that in this way a simple and cheap form of generator might be made for purposes of measurement. The first form of the apparatus, which was the outcome of this idea, is shown diagrammatically in Fig. 2. An open brass tube is screwed to the mouth of the receiver, and another tube is arranged to slide over the first. A narrow side tube leads, as shown, to the microphone. The microphone is in series with two dry batteries, and acts on the telephone through the medium of an ordinary microphone-transformer. If the open tube is drawn out to a suitable distance, the system is set in vibration, and the frequency can be adjusted within wide limits by altering the length of the tube.

When the frequency was considered as a function of the tube length, and plotted out in the form of a

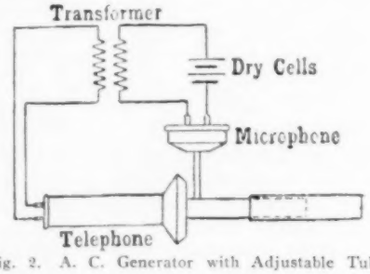


Fig. 2. A. C. Generator with Adjustable Tube.

curve, certain peculiarities showed themselves. The curve fell suddenly when the tube length approached a certain definite amount, and then resumed its regular course. This irregularity was at first ascribed to some property of the membranes of the telephone or microphone. Rather thicker membranes were, therefore, substituted for them; the frequency was thereby affected, but the irregularity remained as before, and corresponded to about the same tube lengths as before. The only possible explanation was, therefore, to be found in the action of the air in the hollow space behind the membrane of the telephone. This was found to be the case, for the irregularity disappeared as soon as the space was filled with paraffin oil, and the apparatus in this form was found to be suitable for frequencies of over 1,000 per second. It became evident at once that the air behind the membrane might also be utilized in the working of the apparatus, and this gave rise to the second form of the apparatus shown in Fig. 3. Here on both sides of the receiver sliding tubes of equal lengths are connected up, and the frequency can in this case be varied steadily from 600 to 1,100 per second.

In order to maintain the state of vibration, the forces, exercised through the microphone, and alternately attracting and repelling the membrane of the telephone, must be adjusted to a certain phase. This force is best arranged so that it is one-quarter of a period in front or three-quarters of a period behind the phase of motion of the membrane. Suppose its phase to be other than this. It can then be resolved

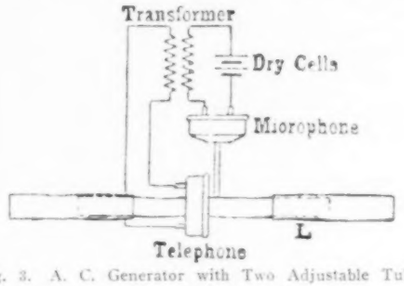


Fig. 3. A. C. Generator with Two Adjustable Tubes.

into two components, of which the one has a phase displacement of a quarter period, and the other has the same phase as the vibration (or it may be the opposite phase). This last component will act as though the air pressure on the membrane had been increased, and in this way the frequency will be somewhat affected.

Magnetizing Telephone Generators

IN an article entitled "A Novel Method for Magnetizing Telephone Generators," H. P. Clausen gives some interesting data in a recent number of the *Electrical World*.

Referring first to Fig. 1, this shows a ring of iron broken at points a and a^1, provided with a magnetizing coil b. Upon passing current through the winding it is well known that the ring magnet is magnetized and even after the current ceases to flow through the windings of the coil a considerable attraction is still observed between the two halves of the ring, this being due to residual magnetism.

This well-known phenomenon was applied to the magneto generator shown in Fig. 4. Here we have an electromagnet of suitable power, built with the pole pieces so arranged that the magneto generator will rest upon the projections and permit the magnetic flux to

pass through the limbs of the permanent magnet, which is shown more clearly by Fig. 5. The first experiments along this line were not very successful, owing to a large portion of the magnetic flux passing from pole to pole of the generator through the armature. The reason for this is clearly shown by Fig. 5.

Recognizing this as the cause for the failure, the armature was withdrawn from the generator and the magnetic flux resulted in thoroughly saturating the permanent magnets of the generator. While subjecting the machine to the influence of the magnet the

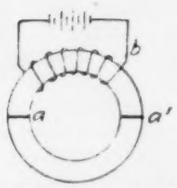


Fig. 1. Broken Ring with Magnetizing Coil.

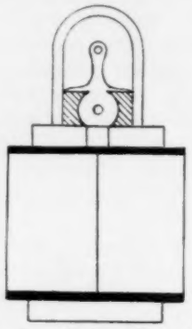


Fig. 2. Magneto Generator.

armature was placed back into position, and, before interrupting the magnetizing circuit, the pole pieces of the magnet were short-circuited by a large block of iron, whereupon the current was interrupted and the generator removed from the pole pieces. Fig. 6 shows, in a diagrammatic way, the block of iron, mounted so as to permit its being slid up against the pole pieces to short-circuit them.

After removing the generator from the pole pieces the armature bearings were screwed into place, and, upon testing the generator so magnetized, an increase, sometimes as high as 25 per cent, was observed in the magnetism. Upon testing the machine for voltage, after short-circuiting, a drop of approximately 20 per cent was observed, which, however, still left the machine something over 17 per cent better, from a voltage standpoint, than could be brought about through any other known method.

When investigating the method of magnetizing telephone generators the first plan consists in opening the

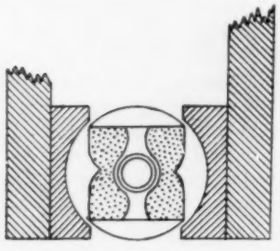


Fig. 3. Detail of Generator.

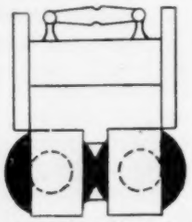


Fig. 4. Method of Short Circuiting Pole Pieces.

circuit of the magnetizing coil after the armature of the generator had been placed in position. It was found, however, that a short-circuiting of the pole pieces before opening the circuit very materially increased the residual magnetism. In connection with this method of magnetizing it is necessary to observe the following precautions:

Under no circumstances must the armature be removed from between the pole pieces of the generator after saturation, for doing so will immediately drop the magnetization something like 20 per cent. Obviously, removing the separate magnets from the pole pieces will also result in the same reduction of residual magnetism, evidencing thereby that we have an effect with the permanent magnet exactly similar to that shown in connection with the description of Fig. 3.

As regards the lasting qualities of a generator magnetized according to the new method, the writer, so far as he has been able to determine, finds that it will last for many months.

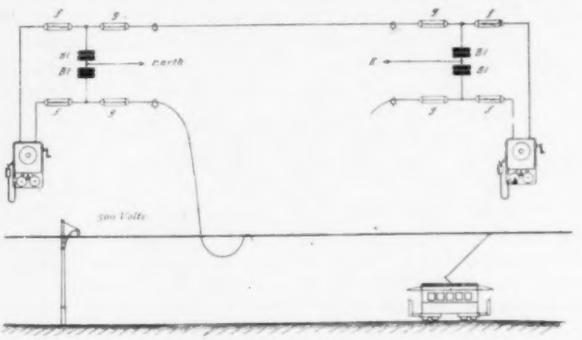
A Vacuum Lightning Arrester

A FORM of lightning arrester much used on the continent of Europe consists of two terminals with a short air gap between them, in a vacuum chamber. The idea is used in this country to some extent.

One such type of arrester is made by Sienens & Halske, Berlin.

The new vacuum lightning arrester is claimed to be of great value in installations the conductors of which consist partly of cable, but mainly in installations where metallic circuits are employed without the use of the earth.

In the former case the cable is subject to injury by lightning discharges, since the conductor is mostly in the immediate vicinity of the earth, so that the insulation will easily break down. On the other hand, metallic circuits (aerial lines), which are well insulated from earth will frequently become charged with such



Protecting Telephone Lines.

a high potential against the earth in consequence of atmospheric influence that, owing to its equalization in the case of a sudden contact with the earth, the inside lines and the apparatus are subject to injury, while attendants are liable to danger. This applies also in the case of contact of the double wire with a heavy current line, in which case the high voltage of the latter passes into the double-wire, without causing the fuses to melt, as an earth connection does not exist. This defect is obviated by the combination of vacuum lightning arresters and fuses, shown in the diagram, since the vacuum lightning arresters *Bl* will produce the necessary earth connection, so that the heavy current causes the corresponding fuse *g* to melt.

The line fuses, marked *f*, protect the apparatus against branch currents.

The new vacuum lightning arrester has the form of a cartridge, with the supply main and the earth

connection arranged on either side, which insures an excellent insulation, so that dust and dampness can no longer cause interruptions. The cartridges are inserted into sockets. Each socket contains also a point lightning protector, either for heavy discharges or as a reserve, when a cartridge has been taken out. The lightning arrester is also fitted with a safety fuse (heat coil) for each line.

Strength of Telephone Poles

A SERIES of experiments upon the strength, the deflection and characteristics of failure of full-sized cedar and chestnut telephone poles, as they are usually set in the ground, is described by Lawrence S. Winchester in the *Electrical World*. Twelve white cedar poles from Main and twelve chestnut poles from Connecticut were tested. The cedar poles were very green and were cut, as nearly as was ascertainable, about five months previous to the tests. The sap was still in them and the bark was left on.

TABLE I.—SUMMARY OF THE RESULTS.

	White Cedar	Chestnut
Modulus of Rupture	Pounds per Square Inch.	
Average	4,000	6,600
Maximum	5,600	9,780
Minimum	3,200	4,500
Modulus of Elasticity	Inch Units	
Average	427,000	710,000
Maximum	974,000	1,260,000
Minimum	239,000	374,000
Position of Fracture	Inches Above the Ground	
Average	30	15
Maximum	115	70
Minimum	0	0

The first ten poles and the anchor pole were set the day before Christmas. At that time there were five inches of frost in the ground. One of these poles was broken on Feb. 25 and the remaining nine were

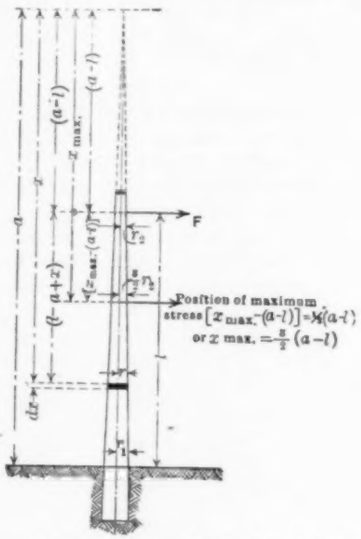


Fig. 1. Diagram of Forces and Points of Application.

tested on March 17, 18 and 19. On March 22 and 23 ten more poles were erected and two of the first lot, Nos. 7 and 8, which had pulled out instead of breaking, were reset, poles Nos. 17 and 18 being set in concrete. This second lot of poles was tested on March 31 and April 1 and 2. On April 12 and 13 the four unused poles remaining and five from the second lot which had pulled out of the ground were set, two of these also being set in concrete. These poles were broken on April 28 and 29.

None of the first ten poles were keyed at either the top or the bottom of the butt, but they were set at least five feet deep. Most of the remaining poles were keyed, but it is very doubtful if this added anything to the strength of the setting unless very large rocks were used. Those poles which were set in concrete only had a ring of it at the top and the bottom of

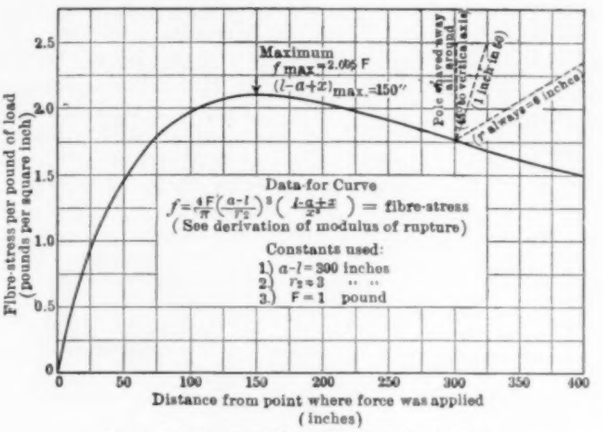


Fig. 2. Variation of Fiber Stress with Distance.

the butt, because here is where the greatest bearing pressure comes, while somewhere in the middle the bearing pressure is zero. This ring of concrete was made about 1 foot thick and 1½ foot wide. In order to increase the rate of application of the load and give the poles less time to give in the ground some of the transit readings were omitted. The poles were also set with a slight lean backward so that they would be more nearly vertical at the breaking loads and there would be less tendency to pull out.

The results of these experiments are rather surprising when one really stops to think how far wood is from being a homogeneous material that the individual results do not vary more from the average. Then, too, the modulus of rupture is a fictitious quantity because it assumes that Hooke's law holds up to the time of breaking. The values given by other authorities were obtained in the majority of cases from small specimens and under artificial conditions. These factors alone are sufficient to account for the higher values and show the unreliability of such data so far as its value in actual construction is concerned.

Physical Connection Question at Los Angeles

The Board of Public Utilities, Los Angeles, Cal., again has under advisement the question of interchange of service by the Home Independent Telephone Company and the Sunset Company, operating in that city. It was proposed to the Board by R. W. Shoemaker, an electrical engineer, that a third exchange be established to provide switching facilities between the manual system of the Bell and the automatic system operated by the Independent Company. He estimated that the traffic could be handled at an extra cost of from $1 to $1.50 for business telephones, and a less charge for residence telephones, while experts from both companies have declared such interchange impossible under any conditions.

The Loading of Long Distance Lines

By Bancroft Gherardi*

THE year 1900 may be considered to have marked the beginning of a very important period in the development of telephony. For some time prior to that date it had been known to those who gave study to the matter that the transmission efficiency of long telephone circuits would be improved by increasing the uniformly distributed inductance of the circuit. Vaschy, Heaviside and others either suggested or unsuccessfully tested the insertion of self-induction in coils on actual lines as a means of increasing their transmission efficiency. No practical results followed from their work and no

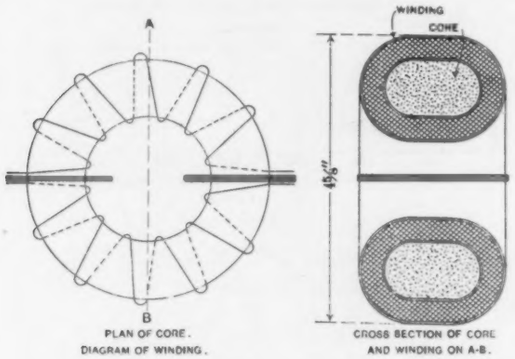


Fig. 1. Cable Loading Coil.

actual progress was made in the matter of using lumped inductance to improve the transmission efficiency of telephone circuits until the year 1900, when the patents of Professor M. I. Pupin, dealing with the reducing of attenuation of electrical waves, were issued.

In the study of any telephone line, with reference to its efficiency as a means of transmitting speech, two important factors must be considered. These we ordinarily characterize as "volume" and "quality."

Volume refers to the loudness of the sound which may be obtained from the telephone receiver at the distant end of the line, and the efficiency of the line as regards this factor is determined by the ratio of the amount of energy received at the distant end of the line to the amount of energy put into the line at the transmitting end.

Quality refers to the clearness of the speech which may be obtained from the current at the receiving end of the line. The efficiency of the line as regards quality is determined by the degree that the shape of the current wave at the receiving end of the line approximates to that of the current wave impressed upon the line at the sending end. A line which would transmit all the frequencies concerned in the telephonic current with equal attenuations of all these frequencies and with the same velocity would transmit without distortion, and its quality might be considered to be perfect.

For the present I will confine my attention to the matter of the volume of speech transmitted. The formula for the attenuation of a telephone circuit, excluding the effects of terminal conditions which react on the portions of the line near the ends, is

$$a=\sqrt{\tfrac{1}{2}\sqrt{(R^2+p^2L^2)(S^2+p^2C^2)}+\tfrac{1}{2}(SP-p^2LC)} \quad (1)$$

in which the symbols have the following significance:

a = attenuation constant per unit length.
R = resistance per unit length.
L = inductance per unit length.
C = Capacity per unit length.
S = conductance per unit length.
$p = 2\pi$ (frequency).

This attenuation constant is a measure of the efficiency of the line, for on any line if the amount of current impressed on it at the sending end is known, and the attenuation constant is known the amount of current at any point along the line may be determined by the formula

$$i = I\,e^{-ma} \quad (2)$$

in which i = the current at any point;
I = the initial current, and
m = the distance from the initial point of the line to the point at which the current (i) is to be ascertained.

Equation (1) may be simplified somewhat by making

$$S = 0,$$

as this term S representing leakage and dielectric dissipation, is always made as small as is commercially practicable and is, in most cases, sufficiently small to be negligible in its effect upon the general result obtained. With this simplification, equation (1) becomes

$$a=\sqrt{\frac{pC}{2}(\sqrt{R^2+p^2L^2}-pL)} \quad (3)$$

An examination of this equation shows that the attenuation constant will be reduced as the inductance of the circuit, L, is increased. The result of the work published about 1900 shows us that we can obtain the same favorable effects by placing suitably spaced lumped inductance in the circuit as would be obtained from uniformly distributed inductance without the fatal difficulties encountered in endeavoring to place any considerable amount of distributed inductance. This work shows us that if more than π inductance coils per wave length are

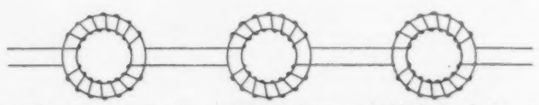


Fig. 2. Diagram of Loading Coil Windings and Method of Connecting Into a Line.

placed upon a telephone circuit the effect of these coils will be approximately the same as the effect of an equal amount of inductance uniformly distributed along the circuit. If less than π coils per wave length are placed the results are unfavorable. As the number of coils per wave length is increased above π the effect very rapidly approaches the effect produced by uniformly distributed inductance so that if as many as six coils per wave length are placed on the circuit the effect of the inductance thus placed is within four per cent of that of uni-

*Paper presented at the Twenty-eighth Annual Convention of the American Institute of Electrical Engineers, Chicago, Ill., June 26-30, 1911.

formly distributed inductance. The wave length in a telephone circuit is easily computed by the following formula:

$$\frac{2\pi}{\sqrt{\frac{1}{2}\sqrt{(R^2+p^2L^2)(S^2+p^2C^2)}-\frac{1}{2}(SR-p^2LC)}} \qquad (4)$$

in which the symbols have the same meaning as in (1) above. To apply this formula to a circuit which it is proposed to load, it is necessary of course to take account of the reaction of the inductance which is to be added to the circuit in the form of loading coils, because this inductance affects the wave length. Therefore, the inductance value in the formula given above must include the proposed loading. In order that all frequencies which are of importance in connection with the transmission of articulate speech shall be cared for by the proposed loading, the frequency employed in this formula must be the highest frequency which takes a necessary part in the clear transmission of speech. It is not found that it is necessary that this spacing of the loading coils should be absolutely uniform. It is important, however, that the spacing should not depart substantially from uniformity.

It is found both mathematically and experimentally that loading makes the attenuation more nearly equal as between the different frequencies which are important in connection with speech transmission and that loading, therefore, increases the clearness of such speech and improves the quality of the line, particularly on underground cable circuits where, on account of the relatively large amount of capacity in relation to the other characteristics of the circuit, the quality without loading is noticeably inferior on long circuits.

Broadly speaking, it may be stated that what we have done in applying loading to long telephone lines is to adopt the necessary measure to enable us to obtain the advantages of a high potential transmission system, that is, of transmitting the electrical energy from the sending end to the receiving end of the line with a high voltage and a small current as compared with the smaller voltage and higher current which is found on unloaded lines. With the telephone current, however, which is of high frequencies, and telephone lines which are often very long, increased reactance placed at the receiving end of the line does not make itself substantially felt at the sending end of the line. To obtain the proper reactance for high potential sending apparatus to work against, it is necessary, therefore, in the case of telephone lines to distribute the reactance along the line.

The electrical characteristics of open wire lines and of telephone cables are substantially different from each other. The following table gives the constants of two typical telephone cables and of a typical open wire line:

Type of circuit	Cable	Cable	Open wire
Loop resistance, ohms per mile	88	28	10.5
Mutual capacity, microfarads per mile	0.07	0.07	0.008
Inductance, henrys per mile	0.001	0.001	0.004
Insulation resistance, megohms per mile	500+	500+	1 to 100

The essential differences between the characteristics of these circuits, from the point of view of loading, will be seen by examining the figures in the above table. In the case of underground cable, the capacity is relatively high and the inductance, on the other hand, is relatively small. On overhead lines, however, the capacity is relatively small and the inductance of the circuit, even before it is loaded, is not negligible. The insulation of cables is constant while that of aerial lines varies with the weather conditions. On account of these differences in the electrical characteristics of these two types of circuit the design of the loading coils used on them, the proper spacing of the loading coils, and the results obtained from loading are somewhat different in the two cases.

LOADING TELEPHONE CABLES.

At the present time we are making very general use of two styles of loading for telephone cables, one of which is characterized as "medium" loading and the other "heavy" loading. In a few cases a third style of loading, known as "light" loading, is employed. These three styles of loading differ in the amount of inductance placed upon the lines and hence in the improvement in transmission obtained from the loading. The heavy loading, as the term would suggest, places the greatest amount of inductance on the line and requires coils placed at closer intervals. This heavy loading employs about 0.2 henry per mile and the spacing coils is about 1¼ miles; medium loading provides 0.1 henry per mile with the coil spacing of about 1¾ miles; light loading employs 0.05 henry per mile with a spacing of about 2½ miles. The coils for these various loadings are made up on similar cores so that the coils differ only in reference to the windings placed thereon. A description of the coil employed for medium loading and the method of applying it to the lines is as follows:

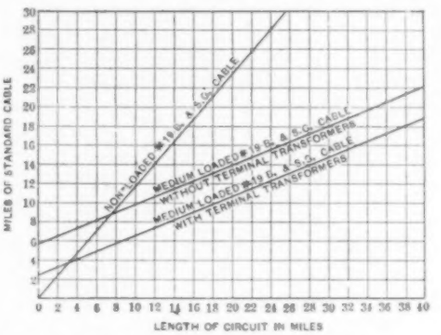

MILES OF STANDARD CABLE
LENGTH OF CIRCUIT IN MILES
NON-LOADED #19 B. & S. GA. CABLE
MEDIUM LOADED #19 B. & S. GA. CABLE WITHOUT TERMINAL TRANSFORMERS
MEDIUM LOADED #19 B. & S. GA. CABLE WITH TERMINAL TRANSFORMERS

Fig. 3. Efficiency of No. 19 B. & S. Gauge Cable Unloaded and Medium Loaded, with Substation Apparatus Located Directly at the Ends of the Circuits.

The coil is of the toroidal type, that is, it has an iron core like a ring. Fig. 1 shows a cable coil. The core is made up of very fine iron wires. Two copper windings are placed on the core, one to go on each side of the line. These windings are also indicated on Fig. 2 which shows the way the coils are connected into the line. The windings magnetize the core in the same direction, that is, the mutual induction is added to the self-induction. Over these windings there is placed a layer of tape for mechanical protection and the whole coil is then thoroughly dried and immersed in a compound to keep out moisture.

Before leaving the design of the coil it is interesting to consider the precautions which are taken to reduce losses in it. This is a very important matter as, while the inductance added to the circuit by the coil produces an improvement in the transmission efficiency to the circuit, any loss of energy in the coil means, of course, a reduction in the efficiency of the circuit, and with poorly designed coils it would be easily possible to bring in losses so large that they would over-balance all the gain from the loading and leave the circuit poorer than before. These losses must be particularly guarded against because they are cumulative.

The first loss to be considered is a dissipation loss resulting from the resistance of the copper winding of the loading coil itself. This loss cannot be entirely eliminated, but it may be reduced as much as may be desired by increasing the cross-section of the winding. There are, however, practical limits to this, as the increase in the size of the winding increases all the mechanical dimensions of the coil and also tends to increase certain other losses.

A second possible loss in loading coils may also develop in the copper winding. If the cross-section of

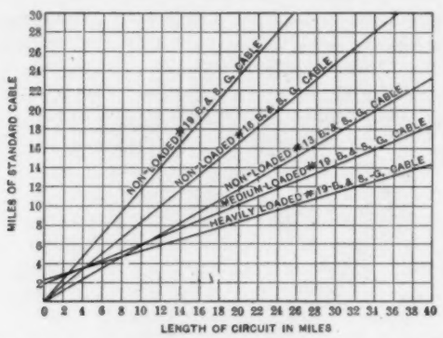

MILES OF STANDARD CABLE
LENGTH OF CIRCUIT IN MILES
NON-LOADED #19 B.&S. G. CABLE
NON-LOADED #16 B.&S. G. CABLE
NON-LOADED #13 B.&S. G. CABLE
MEDIUM-LOADED #19 B.&S. G. CABLE
HEAVILY LOADED #19 B.&S. G. CABLE

Fig. 4. Efficiency of No. 19 B. & S. Gauge Cable Loaded (Medium and Heavy), with Terminal Transformers and One Mile Unloaded Loop at Each End; Also Efficiency of Unloaded Cables of Various Gauges.

the conductor used for winding the coil is large, eddy currents may form within the conductor itself and these would produce substantial losses.

Practically this factor is small in cable loading coils, but in open wire coils where a conductor of greater cross-section must be employed it has been found necessary to strand this conductor and to insulate the various strand from each other.

In the iron core of the loading coil there are also several possible losses. In the first place, there is the hysteresis loss. After a great deal of work it has been found practicable to obtain special grades of iron which when worked within certain limits of magnetization are substantially free from hysteresis losses. This at once imposes a limitation on the design of the loading coil and affects the proportioning of all of its parts.

Another loss which may take place in the core of a loading coil is that due to eddy or Foucault currents which may develop in the material of the core itself. In the case of loading coils it has been necessary to construct the cores of extremely fine wire and to coat this wire with a film of insulating material.

Certain other losses must also be guarded against. If a loading coil when magnetized gave an external magnetic field and there were any conducting materials in this field, eddy currents would be produced in this conducting field and would represent a loss of energy through the circuit. Similarly, if there were any iron or other magnetic substances in this field there would be likely to be hysteresis losses in this iron. These losses have been guarded against by adopting the toroidal form of coil already described and placing the windings on it in such a manner that practically no external magnetic field is in any case produced. The designing of loading coils in this manner has not only eliminated external losses, but makes it possible to place loading coils in close proximity to each other without introducing cross talk between the circuits involved.

The direct current resistance of the medium loading coil is about four ohms. The alternating current resistance of this coil, at a frequency of about 800 periods a second, is about nine ohms. This relatively small increase of resistance at such a high frequency is a good indication of the skillful design and careful manufacture of these coils.

The results obtained by applying medium loading to No. 19 B. & S. gauge underground cable, having a capacity of about 0.070 microfarads per mile, are shown in Fig. 3. In this figure is also shown the transmission efficiency of the unloaded cable. All of these transmission efficiencies are measured in terms of what we call standard No. 19 gauge cable. This standard 19 gauge cable is cable having a resistance of 88 ohms per loop mile and a mutual capacity of 0.054 microfarads per mile. Cables as now manufactured have in general higher capacities than this, but when the earlier transmission tests were made cable having a mutual capacity of 0.054 was in common use and was therefore adopted as the standard and it has been convenient to retain it as such. Wherever in this paper, unless otherwise stated, the efficiency of a circuit is spoken of as being equivalent to so many miles of standard cable or of so many miles of cable, the cable referred to as the unit of measurement is 19 gauge standard cable as defined above. It is for this reason that the efficiency of the unloaded cable in Fig. 3 is not quite equal to that of the standard cable used as the unit of measurement.

The efficiencies of the loaded circuits, shown in Fig. 3, are those obtained with substation instruments located directly at the ends of the loaded circuits. One curve is given showing the results obtained by the use of terminal transformers and the other without the use of such devices. These curves bring out clearly a peculiarity of loaded circuits which should be considered at this point. The loading of a circuit, either underground or aerial, brings in at the ends of the loaded circuit whether the circuit is connected directly to substation instruments or to unloaded circuits an effect which we have called reflection losses. That is to say, at the ends of the loaded circuit there are certain losses which take place which are substantially independent of the length of the

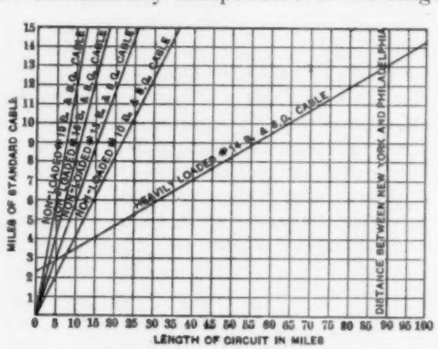

MILES OF STANDARD CABLE
LENGTH OF CIRCUIT IN MILES
DISTANCE BETWEEN NEW YORK AND PHILADELPHIA
HEAVILY LOADED #14 B.&S. G. CABLE

Fig 5. Efficiency of No. 14 B. & S. Gauge Cable with Heavy Loading (New York-Philadelphia Cable); Terminal Losses with Terminal Transformers and One Mile Loop; Also Unloaded Cables of Various Gauges.

loaded circuit involved. These losses as between loaded and unloaded circuits are dependent upon the relative electrical characteristics of the loaded and unloaded circuits. In the case of substation instruments, connected directly to the ends of a loaded circuit, the terminal losses are dependent upon the relative electrical characteristics of the substation instrument and of the loaded line. Terminal or reflection losses, of course, also exist between unloaded lines of different characteristics, for instance,

as between unloaded underground cable and unloaded aerial lines. They would also be found between substation instruments and unloaded lines of various kinds. In all these cases, however, they are small in magnitude and it is only in the case of loaded lines that they assume such proportions that they must be given consideration in connection with general engineering.

I have been speaking of the terminal losses observed in connection with loading as though they pertained particularly to the loaded line. It has been convenient to so speak of them but, of course, they actually pertain to the combination of loaded lines with unloaded lines or standard substation equipment, and properly are no more associated with one than with the other but rather result from a combination of the two. As, however, the substation instrument and the unloaded lines were in service for a considerable time before the use of loaded lines, it has been convenient to associate these reflection losses with the loaded lines and consider the electrical efficiencies of the unloaded lines and the substation instruments to remain unchanged.

Various devices have been successfully employed to reduce terminal losses, although no plan has been worked out which would completely eliminate them. The plan used most successfully today for eliminating terminal losses is a device known as a terminal transformer. This is a transformer or repeating coil which differs from the standard telephone repeating coil in that there are more turns on one winding than on the other. It is used in the same way as an ordinary transformer in electric light practice, the high potential side being connected with the loaded line and the low potential side with the unloaded line. For ordinary conditions of loading the ratio of the two windings is usually either 1 to 1.4 or 1 to 2. The effect of the terminal transformer in reducing terminal losses is well shown in Fig. 3. The terminal loss of the two ends of a medium loaded line without terminal transformers is about 5.75 miles of standard cable. With terminal transformers this is reduced to 2.5 miles. These figures are for cases where the telephone substation apparatus is located directly at the ends of the loaded line. Where, between the loaded line and the substation apparatus, there is a length of unloaded line it is found that terminal losses are not so great as if the terminal apparatus were directly at the ends of the loaded

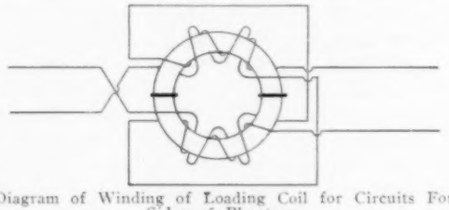


Fig. 6. Diagram of Winding of Loading Coil for Circuits Forming the Sides of Phantom.

line. The extent to which the varying amounts of unloaded line reduce terminal losses are shown by the following figures:

Amt. of 19 gauge unloaded cable at each end of loaded circuit	Amount of terminal losses at both ends of a loaded circuit—medium loaded	
	Without terminal transformers	With terminal transformers
None	5.75	2.5
1 mile	4.0	2.0
2 miles	3.0	1.50
3 miles	2.2	1.15
4 miles	1.6	1.0
5 miles	1.25	0.9

While terminal losses are substantially independent of the length of the loaded line, they are affected by the character of the loading of the line. The heavier the loading the greater the reflection losses. While with medium loading the reflection losses, as shown by the above table, with no unloaded cable at the ends of the circuit are 5.75 miles without terminal transformers and 2.5 miles with terminal transformers, the corresponding figures for heavy loading are 7.8 miles and 3.5 miles. These figures are, of course, reduced as in the case of medium loading, by having unloaded cable at the ends of the loaded circuit.

If it were not for these terminal losses it would be practicable, theoretically at any rate, to indefinitely increase the efficiency of a 19 gauge circuit by adding more and more inductance to it. Even without terminal losses,

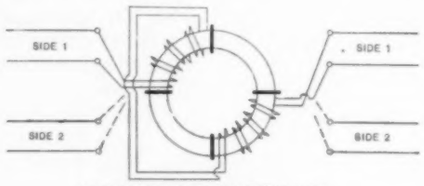


Fig. 7. Diagram of Winding of Loading Coil for Use on Phantom Circuits.

however, this could not practically be done, because more and more loading coils would have to be added as more inductance was added, and these would in turn bring in larger and larger losses until finally the further gains from adding inductance would be offset or more than offset by coil losses. The increasing effect of leakage as the weight of loading is increased also has a limiting effect. Aside from these effects, terminal losses, which increase as the amount of inductance added to the circuit is increased, places a limitation beyond which it is not advantageous to increase the amount of loading on the circuits. This is illustrated by Fig. 4, which gives the efficiency of medium and heavily loaded 19 gauge conductors and on which, for the purposes of comparison, the efficiencies of various gauges of unloaded circuits are also given. It will be seen from this that by taking into account the reflection losses which are here given at about an average for various conditions, the medium loaded circuit is more efficient than the heavily loaded circuit in lengths up to four miles. Beyond that point the heavily loaded circuit is more efficient, although even at 12 miles the difference is not largely in favor of the heavy loading.

It is interesting to consider from this diagram what results have been obtained from loading 19 gauge conductors. For a length of circuit equal to 4.5 miles the 19 gauge conductor with medium loading is as good as a 16 gauge conductor unloaded; that is to say, loading has made the circuit containing half the copper as good as the larger circuit without loading. For a length of 11 miles a loaded 19 is as good as unloaded 13 weighing four times as much as the 19 gauge conductor.

For underground circuits, requiring a greater transmission efficiency than can be obtained by the use of heavily loaded 19 gauge cable circuits, it has been found best, all things considered, to employ a larger gauge of wire rather than to load more heavily. Many cables containing 16, 14 and 13 B. & S. gauge conductors have been laid and loaded.

The most interesting existing cable containing large gauge conductors is the New York-Philadelphia cable which was laid several years ago between these two points in order to provide additional circuits and to in-

sure the service against storm damage. Most of the circuits in this cable are 14 B. & S. gauge and they are heavily loaded. That is, there is 0.2 henry per mile added to the cable circuits by means of loading coils. The results obtained on these circuits are given in Fig. 5 assuming average terminal conditions. The results obtained by this loading are most satisfactory. The distance between New York and Philadelphia, following the route of the cable, is 90 miles and this distance is indicated on the diagram. It will be seen that for this distance the circuits have an efficiency of 13 miles of standard cable. If unloaded, these circuits would have an efficiency of about 60 miles of standard cable. Over such circuits no commercial service could be given between New York and Philadelphia. Without loading, even 10 gauge conductors would have given unsatisfactory results, so that by means of loading we have been able to obtain results between New York and Philadelphia over 14 gauge conductors that could not have been obtained with conductors of much greater weight without loading.

While this New York-Philadelphia cable represents the longest loaded underground cable today in use anywhere in the world, a project has been approved and is now under way which will far surpass it. This project is for an underground cable extending between New York and Washington in one direction and New York and Boston in the other. The largest conductors in this cable will be No. 10 B. & S. gauge and by means of loading we confidently expect that we will be able to obtain thoroughly satisfactory results between New York and either Boston or Washington, and that it will even be possible to obtain service through this cable between Washington and Boston should storm damage to the open wire lines render this necessary. The loading of this cable will be of particular interest as it will represent the first large application of the phantoming of loaded cable circuits and the loading of phantom cable circuits. In order to accomplish these results it is necessary to adopt special arrangements of the windings of the loading coils. The windings on the loading coil used for loading the side circuits are arranged as shown in Fig. 6. With this arrangement of winding, the effect of the telephone current in the side circuit, which current flows in opposite directions in the two sides of the circuit, is to magnetize the core of the loading coil in the same direction throughout and to produce no consequent poles. The loading coil thus acts, in as far as the side circuit is concerned, exactly like the loading coil with the simple winding shown in Figs. 1 and 2. In building up a phantom circuit this side circuit, however, becomes one side of the phantom, and the telephone current in the phantom circuit traverses the two wires of the side circuit in parallel. Such a current flowing through the windings of such loading coils as are shown in Figs. 1 and 2 would magnetize the two sides of the core in opposite directions and produce consequent poles at the two sides of the core. This would not only bring in serious losses, but also crosstalk which would be very difficult to deal with. The current in the phantom circuit flowing through a coil with windings on it as shown in Fig. 6 does not magnetize the loading coil at all, as each winding is neutralized by a corresponding winding on the other side of the line. Such coils may be used to effectively load the side circuits of a phantom combination and in as far as the phantom itself is concerned they act only as resistance which is very small in amount. This, however, does not load the phantom circuit. which of course is a desirable result to attain. To load the phantom circuit a coil with windings as shown in Fig. 7 is employed. It will be seen by tracing out the winding of this coil that to the current flowing in the phantom circuit it acts like an ordinary loading coil, that is, all windings magnetize the core in the same direction. To currents flowing in either of the side circuits, however, it acts only as dead resistance. The arrangements described above in connection with the application of loading coils to phantom circuits and to the side circuits of phantom circuits have been successfully applied to open wire lines as well as to underground cables. (*To be concluded.*)

Maryland Commission Reports

The Maryland Public Service Commission has received from its chief engineer, Charles E. Phelps, a summary of the report made to the commission by Messrs. D. C. and William B. Jackson, Boston, who were appointed to report on a petition made some months ago by the Chesapeake and Potomac Telephone Company for permission to establish a new schedule of rates. The business of the company was thoroughly investigated in this report and it shows that the company has approximately 29,000 main telephones with 14,000 extensions, main telephones being classed as all telephones in the system excepting extension apparatus and those connected with branch exchanges. There are 810 flat-rate business telephones and 6,732 flat-rate residence telephones, with seven private branch exchanges on the flat rate with 341 telephones. The calls for the past year aggregated nearly 43,000,000, of which 21,750,000 were over the flat-rate lines; 15,952 over the message-rate lines; 1,816,000 coin-box telephones; 2,373,000 public pay stations; 717,000 attended pay stations. The report recommends the adoption of the schedule proposed by the telephone company with two exceptions: First, that the part of the schedule which would abolish the party-line coin-box telephone, be amended placing these telephones on a straight-message basis with no additional rental charge, placing the number of messages for a year at about 900 for a direct line and 600 for a two-party line, allowing not more than four coin-box telephones to any one line. Second, that the rate for party-line residence telephones be made on the basis of $2 a month, with forty local messages per month instead of thirty, making this rate the same as for a similar service in Boston, so that no local message on this class of telephones will be more than five cents. The report also recommends the abolishment of the present flat rate of $125 a year for business service, both direct line and metallic circuit and $78 a year for direct line, grounded circuit. The schedule for moving a telephone at subscribers' requests allows $2.50 for changing the location of a telephone in the same building, $6 for moving it from one building to another, and $2.50 for moving an extension telephone from one building to another. It is recommended that not more than two message-rate telephones be connected on any one line, either business or residence. It also recommends the retention of the rate of $48 a year for flat-rate residence service on the ground that the residence telephone is used much less than the business telephone. The rate of $6 a year is considered a fair charge for extensions. As stated in the report these commutations are based upon a return to the company of 8 per cent on the book values of the company.

Digest of Foreign Telephone Literature

Translated for Our Readers

USE OF ACOUSTIC AND ELECTRIC RESONANCES IN HYDROTELEGRAPHY.

BLONDEL, in a recent meeting of the L'Academie des Sciences, Paris, reported on his trials in transmitting signals by water. Such signals are given by divers bells, and caught by a microphone, under water, and sent to the ship through a transmitter. These three instruments must be in harmony as regards their fundamentals, and the following method is used to tune them: The method is based on the use of an oscillograph, combined with a microphone, and compared with an electric tuning fork. The oscillations of the diver's bell, caused by a striking mechanism worked by hand, are caught by a microphone whose frequency is much higher than that of the bell, and which has a considerable dampening effect. An oscillograph was shunted into the microphone current circuit, and a second oscillograph connected to an electric tuning fork, which could vibrate at the rate of 200 periods per second. Investigations showed that one single striking of the bell, even in the water, caused a progressive series of oscillations, whereby the dampening effect was higher than that in air, owing to the liquid surroundings. The bronze bell used for the experiments weighed 82 pounds, and gave a tone which made about 1,025 double vibrations in air and 750 double vibrations per second in water, being long enough to call forth a responsive musical sound in the receiver as also resonance phenomena in some cases. These numbers of vibrations are, however, subject to great changes with increasing distance, and the receivers must be constructed according to the distance and the periods of vibrations.

The receiver microphone consists of a metallic diaphragm in an air-and-water tight compartment, and it acts upon microphone carbons by means of mechanical or aerial transmission. This diaphragm has a definite oscillation (fundamental tone) with a considerable dampening effect in air and a stronger effect in water. This phenomenon is, however, made very complicated through the influence of the internal transmission and the natural vibration of the carbon microphone, to which the membrane transmits the water vibrations.

The kind of connection between diaphragm and the microphone contact makes a great difference in the transmission of sound. To determine the real resonance conditions the author used a direct method by influence on a metallic diaphragm by means of a constant current source, whose number of vibrations can be changed uniformly to determine the maximum amplitude. Blondel constructed a special electric siren for this purpose, which meets conditions in the limits between 250 and 2,500 vibrations per second and can be used equally well in air or water.

The telephone receiver must also be in electromechanical resonance with the periods of vibrations of the signals before it can be used in connection with the microphone. This is easily accomplished by a proper choice of the diameter and strength of the diaphragm as also of the electric constants of the coil. The period of vibrations upon which the resonance depends is determined by exposing the instrument to the constant voltage of a pure sine-shaped alternating current, whose period of vibrations is uniformly changed, observing the maximum vibration amplitude through a mirror attached to the diaphragm. The complete resonance permits the extension of the hydroelectric signals to a great distance, as also to transmit them to several stations, using various periods of vibration for this end. The vibrations are best retained within the 500 to 1,200 vibrations per second limit. —*La Lumiere Electrique.*

THE RELATIVE EFFICIENCY OF MANUAL AND AUTOMATIC SYSTEMS.

Although the German cities Hildesheim, Altenburg and München seem to have quite favorable results with automatic telephone operation, it seems that the Austrian authorities do not place great trust in the system, since they have installed the semi-automatic system only in the new exchanges at Graz and Vienna. Hamburg, which is equipping a new exchange uses this system, and Amsterdam also seems to consider it more economical than the automatic system. It may be interesting, therefore to give comparative statements of the different systems, showing their efficiency, and this all the more, since the literature on that phase of the subject is scarce. The following tables give comparative results of the different systems:

Time in Seconds.	Manual System, one exchange.		Manual system, two exchanges.	Semi autom. Strowger System, impulse sender.	Strowger automatic System, with selector disc.	Automatic Strowger System, with Dietl sender.	Bloss Automatic Combination Sys.
Taking receiver off hook.....	1	1		1	1	1	1
Time waiting for answer....	3.5	7	(2 act.)	3.5	...	...	...
Asking for number.....	6.5	9	(2 act.)	6.5	...	...	...
Waiting for second party to answer and connecting..	9	9.5	(2 act.)	8.5	7	8.5	7
Time for conversation.....100		100		100	100	100	100
Hanging up receiver.....	1	1		1	1	1	1
Disconnecting	3.5	3.5		...	...	...	...
Set current impulse sender.. ..	...			1.5	...	4.5	...
Action of current imp. sender ..	...			7	...	7	...
Setting selector disc and calling..	...			...	8.5	...	...
Press button and ringing	...			...	...	...	4
Total time for making successful connection	20	26.5		28	16.5	21	12
Total time for busy wires....124.5		131		129	117.5	122	113

The time required for making connections is, of course, the important figure, while the second total, which gives the total time for a busy wire is only relative, as the time of conversation varies, and the 100 second mark has only been taken as an arbitrary standard to make a valid comparison. The above table shows the superiority of the semi-automatic and full-automatic system over the manual system of telephone service from the time saving standpoint. These figures have been compiled from operating data and are substantially correct and applicable to practical work, and have not been compiled with the view of bringing the automatic system into favor or creating an unduly favorable impression for the same.—*Elek. Zeitschrift.*

NEW TYPE OF REINFORCED CONCRETE TELEPHONE POLES.

The use of reinforced concrete poles for telephone and telegraph lines is not new, and in recent years these poles have taken the place of wooden or iron poles to a large extent. They are superior to the wooden poles, as they are more permanent and resistant, and at the same time do not need the care and frequent coats of paint to prevent rusting, as is the case with iron poles. There are several types of reinforced concrete poles, both square and round. The latter are either moulded in cylindrical moulds, or else are made by the centrifugal process described in a previous number of this paper. The new Saxonia and Bavaria poles of the Wolle Company in Leipzig are, however, of an entirely new type. They are constructed with square openings running from a height of about six feet above ground to the top of the pole and enable the wire and linemen to climb up without using climbing irons or spikes. These square or oblong openings, moreover, give the poles a very pleasing and harmonious appearance, and would recommend their use in residence or city districts where the appearance of the telephone poles is of some importance to the community. One great advantage of these poles over the centrifugally made poles is the lower cost, as no expensive machinery is necessary for their construction. The cross section of these poles is oblong, and the openings run through the broader sides. The double steel reinforcement lies near the outer edges of the two narrow sides. The four long steel rods, which form the corner reinforcement and give the support to the pole, run from top to bottom and are connected by stirrups and by diagonal steel rods. The poles are made in the following way: After the steel reinforcement which forms the skeleton of the pole has been connected and finished, the steel frame is placed in a horizontal position into a wooden mould, whose sides are removable. Then the concrete is poured over the steel into the mould, the proportions varying according to the nature of the cement and gravel, being usually one part cement to four parts gravel and sand. After removing the lateral portions of the mould, the poles are left in a horizontal position for two or three days and are then taken to a sandpit, where they remain until used. These poles are 30 to 36 feet high, five to six feet of the base being anchored in the ground. The various stresses and forces to which poles are exposed are carefully computed and met by corresponding reinforcement. Tests were made with several types of poles which were designed for a breaking load of 10,224 pounds to the square inch. These poles were set into the ground as in real practice and braced on both sides by heavy stays. The pressures and loads were then applied, the loads amounting to 6,020 pounds to the square inch, whereupon the deviation from the normal (perpendicular) was found to be 3.6 inch. When the strain was removed the pole returned to within 0.4 inch of the original position. A second pole which was tested by a load of 2,612 pounds to the square inch showed a deviation of 1.1 inch from the normal and returned to within 0.07 inch of the original position. The poles were then subjected to a load up to the breaking point and broke respectively at a load of 13,134 and 10,708 pounds to the square inch. The second pole broke just above ground at the position of the greatest moment of force, *i. e.*, by overcoming the normal resistances of the cross sectional area, while the first pole broke near the upper end by the shearing of the openings near the top of the pole. The dangers of destruction due to bending and shearing stresses are thus seen to be equally great and the strength of the poles is shown by the high breaking load which was necessary to strain the poles to their limit. These poles are designed to sustain a lateral pressure or wind pressure of 2,556 pounds to the square inch with a fourfold factor of safety.—*Armierter Beton.*

THE TELEPHONE IN THE FIELD.

While the telegraph was used extensively in warfare for many years, the telephone is of more recent use in that connection, and its great value in directing the movement of large bodies of men was first demonstrated in the Russo-Japanese war. The German army has now equipped all its troops with telephone equipment, enabling them to be in constant speaking communication even with the foremost outposts in the field. Every larger command or division has a special telephone corps attached, which consists of trained telephone men under the command of a sargeant, who is also a telephone man. All of the men are mounted, and the necessary equipment is taken along on trucks. Each division of this corps can lay four miles of telephone lines and equip four stations with the material on hand, taking about 20 minutes to lay 0.6 miles. These men are to establish communication between the troops in battle, the artillery and the staff commanders, as also between the staffs of the different army corps. The infantry is also provided with a special body of men, called the infantry telephone corps. This part of the service is only a new department and has not advanced very far as yet. But the idea is to equip each infantry company with such a small division and with a telephone outfit. The instruments are made in such a way that they can be carried by the men in the troop and that communication can be established in the least possible time between the outposts and the main body of troops.

The artillery carries this equipment on a special gun carriage, and the modern method of warfare in which artillery firing is done from protected positions and directed by the commanders at some distance back of the danger zone, makes the telephone one of the necessities for preserving life and obtaining an effective fire.

With the cavalry each regiment has a telephone patrol consisting of eight men and a sargeant with telephones and four miles of wire and supplies of wires are carried along on a truck. In this way all of the troops are equipped with telephones permitting rapid and efficient communication at all times.—*Zeit. f. Schwachstromtechnik.*

Kansas Commission Rules on Stock Issues

Kansas telephone companies may go on consolidating under the public utilities law but they can't water stock. The State Public Utilities Commission has made a ruling to that effect. Several telephone companies have applied to the commission for permission to consolidate into one company. The commission is willing providing the consolidation is made under certain restrictions. The consolidated company must not have a capital stock in excess of the value of the properties of the different companies going into the consolidation.

Rural Line Methods in the South

By L. K. Smith*

THE Gainesboro Telephone and Telegraph Company operates in nine counties in the northwest portion of Georgia in the old red hills, a fertile and healthful section of the state, west, northwest and southwest of Atlanta. Our country territory is chiefly occupied by white farmers owning and occupying their small farms. Carroll county, where we have made the greatest development, has more white farmers on forty acre tracts and more white children of school age in the country than any other county in Georgia. The population of this county is more than thirty thousand. The chief product of this section is cotton, but the farmers are beginning to diversify and considerable corn, hay, oats and other crops are raised. Since cotton has advanced to 15 cents the farmers are very prosperous and are clamorous for rural mail routes and telephones, but they are close traders and are generally unwilling to pay the city prices for telephone services. We operate fourteen exchanges and several hundred miles of toll lines, having grown up within the last ten years from a small beginning. Early in the history of our company we built metal circuit lines into the country and charged rentals at the rate of $1.50 per month. These contracts are still in force, many of them, but we have never considered this service profitable except as feeders for exchanges with which they are connected. They strengthen city exchanges and tend to prevent competition. Another feature which is against this kind of development is that the rural subscribers have no individual investment whatever and feel at perfect liberty to give up their telephones at any time. While many of our subscribers on these contracts stay with us from year to year others abandon their contracts after a year or two and leave us with large investments on our hands. Many farmers regard the payment of $1.50 per month as too high for telephone service.

In the early part of 1909, R. B. Babbington, general manager of the Piedmont Telephone and Telegraph Company of Gastonia, N. C., paid us a visit at our request and went over our system. He found that we had excellent toll lines in almost every direction which were not loaded to their capacity, sometimes having only two wires when they could carry, just as well, twenty. He suggested the building of one-wire or grounded country lines on these toll routes and charging a rental of $1 per month. He then had in operation something over one thousand telephones on this basis and considered it a very profitable proposition. We were slow to take hold of it as we were partial to the metallic circuits. However, later in the year we began experimenting on these lines and found them quite satisfactory. The service is not so quiet; in fact, there are times on hot days when it is almost, if not quite, impossible to communicate over these lines. But metal circuits often become grounded and are crossed out so that service is interrupted. We have considerable cross talk, but the fact that the subscribers get a cheaper rate reconciles them to some noise and cross talk on their lines. The grounded line will bear much more abuse and still perform its functions; it falls to the ground, goes through the trees and becomes crossed up with other lines and still it talks, whereas a metal circuit crossed is no good for anything. The farmers build and maintain their own pole routes where the lines leave our main routes. In fact, by our contract they are to keep up and care for all side lines after we have once put the wire on the poles erected by them. Another feature is that we do not go out to their stations for the purpose of clearing instrument trouble, but the subscriber brings his telephone to our office for repair and also returns it in case he desires to discontinue service. This saves us large amounts for livery bills while it entails very little expense on the farmers, for they can bring their telephones in their buggies as they come to town. They come to our office and get batteries which they install themselves without expense to the company.

The subscribers pay their rentals twelve months in advance. If a subscriber is a land owner and perfectly reliable and finds it inconvenient to pay his bill at the time the telephone is installed, we take his note bearing interest at 8 per cent, the legal rate in Georgia, from date and due at such time in the fall of the year as he will be likely to sell his cotton. We have accepted notes from quite a number of our subscribers and have experienced no trouble in collecting these notes. The farmers of our section have plenty of money in the cotton season and we anticipate no trouble in this line.

We contract with the subscribers for at least one telephone to the mile. It is necessary to look carefully to this item because miles in the country are very elastic where people want telephones. We generally secure the services of some man who is well acquainted with the community to go among the farmers and secure signatures to our contract. We then furnish the nails and brackets for the subscribers and they make the attachment to the poles before putting them up. They expect you the next day with the wire and telephones, but this is often impossible because we have only one crew of regular construction men outside of our trouble men at the various exchanges. So far as we can we have the trouble men string the wire and put in the telephones, but the demand has been so great since we inaugurated the $12 contract that we find it necessary to keep a small construction crew of three to five men to work on the farmers' lines. We occasionally shift them to serious cases of trouble and to such other work as is necessary to be done. We make out contracts for the period of three years, but we verbally agree that if the subscriber has a good reason for giving up his telephone in less time he can do so, and if he has paid anything in advance on rentals we will return the part not earned by service. We have lost practically no subscribers on this contract. Generally if a man wishes to give up his telephone there are two or three of his neighbors who are anxious to take it. We provide that there must be at least six tele-

*Address delivered before the Florida Telephone Association.

phones on each line and then we run them up to as high as twenty, and we have had twenty-five on a line at one time. We find that by using 2,500 ohm ringers and five bar generators we can give fair service with even twenty-five telephones on the line when we have condensers installed. Subscribers will listen and it is necessary to make provision for ringing past them. However, if one will ask a subscriber to hang up his receiver and help ring central on some station on the line the request is generally complied with.

In order to economize on battery consumption, we provide that we will furnish only one set of batteries per annum to each station; then if the subscribers permit them to be used up by eavesdropping they do it at their own expense. This we think has a good moral effect. We contract to limit conversations to three minutes and give long distance messages preference in all cases. This can not be done absolutely, but we think it well to have the power reserved in the company. In the building of side lines the subscribers contract to carry the reel, haul the wire and do such other work as may be necessary to help our workmen. They also board our men. In this way they feel that they have an interest in the system; they have contributed poles, labor and time to the construction of it and in a sense the line is theirs. We believe it is well to foster this feeling. In this way these country lines are mutual affairs and we encourage the farmers to form themselves into companies and associations and act through their officers. While we reserve the right to put on any number of stations we think proper, still as a matter of practice we refer the applications to the subscribers on any particular line. It pleases them to be consulted about these matters and we have no trouble in securing their assent to a reasonable request.

We have a provision in regard to the ownership of the poles furnished by the subscribers whereby they shall become the joint property of all the subscribers, present and future, who continue the telephone service, with the right vested in the Gainesboro Telephone and Telegraph Company as trustee to continue the use of such poles and route as established for the purpose of furnishing telephone service indefinitly to such present and future subscribers, but without expense to the company, so if a man should fall out with other subscribers or the company and give up his telephone he has no further claim on the material or labor he has contributed.

We teach the subscribers to look after their lightning arresters and keep them in order, to install new batteries, so that we find the maintenance in this branch of the service very small. We have to keep up our toll lines in any event, and it is very little additional trouble to look after the subscribers' lines on the poles. Beyond that the subscribers themselves look after and take care of the lines.

The average investment on a farmer line telephone circuit is very much less than a similar investment in the city. We figure that aside from the pole investment, which is already made on account of the toll lines, our average investment per station for country telephones will not exceed $30. We are only in our second year on this proposition, yet we believe it is a solution to the telephone problem for the country in our section. The demand exceeds our power to supply, whereas on the $18 proposition we had a hard pull to make any development at all, though our investment was more than double that necessary for the $12 proposition.

We regard it as very important to connect the country with the town; their interests are mutual. A country telephone calls for one in town, and one in town calls for one in the country.

We have another plan which is similar to that used by the Southern Bell Company; that is, we furnish service to subscribers in the country and charge them 50 cents per month each. They build and maintain their own lines, while we meet them at the city limits. We must have at least six telephones on each line of this character, and in order to avoid a large amount of bookkeeping and expenditure for postage, we contract for them to pay twelve months in advance. We build to the city limits either a metal circuit or grounded line at the subscriber's option, for the $6 a year subscribers. They organize a company and act through their officers. We have both these plans in operation at Carrollton, Ga., as well as a number of subscribers paying $1.50 per month. This being our headquarters and being a good field for country development the Carrollton exchange has grown wonderfully. Less than six years ago we had on this exchange 174 subscribers; now we have in the city and the country nearly nine hundred, with contracts signed up for nearly one hundred more in the country.

In our hurry to put the country telephones to work we brought quite a number of circuits through our cables, and we have found that this was a serious mistake, for our section of the country is subject to terrific thunder storms and our cables have suffered in consequence. We are now running these country circuits from the city limits to the central office on covered iron wire.

There is one item I should have mentioned sooner but overlooked it at the proper place, and that is in working up a country line we endeavor to place as many telephones in a particular community on the same line as possible, so that neighbors will be congenial. A large per cent of the communications over the country lines will be among the subscribers on that line. They talk to each other, call their doctors who are on the line, or the merchants and friends in town. While the service is not the best and most expeditious, still they are getting it cheaper than their friends in town and they are satisfied. They keep their telephones and pay their bills and that is interesting to the company.

Denver Connected with El Paso

Denver, Colo., gave its greetings to El Paso, Texas, over the telephone for the first time recently. From the telephone company's offices George Spalding, commercial agent of the company, spoke to Mayor Kelly of El Paso at the other end of the wire, and telephone communication between Denver and the borderline of Mexico, 750 miles away, was launched.

The establishment of the El Paso line is another link in the chain which is placing Denver in oral communication with the most distant parts of the country.

A wire has been constructed from Tucson, Ariz., to El Paso and looped with the one between Tucson and Denver.

The first trial of the new line was a great success. Those who talked over it heard each other distinctly.

Who's Who in the Telephone Game

Facts and Fancies About a Man You Know or Ought to Know

MY mother was Amanda Caroline Humble and my father, Lewis Thomas Mock. They were the first children of two pioneer families who settled in northern Indiana when the Indians were still there. They helped their fathers build their homes, clear the land and till the little patches of ground. They slept in beds that they made themselves. The baking was done in an outside oven. The soap was manufactured on the premises. They lived in an environment that was rough and honest. Father had six brothers; mother two half-sisters, six sisters and two brothers.

Those were the happy days!

Of his family, father was the only one who went to war. I forget his regiments, for he was in and out and back again several times. He was with Sherman to the sea and at Washington when the thing was all over but the shouting. When he got back to Indiana he ran away with my mother; stole her off the lean-to kitchen, clapboard roof, where she had slid out of the loft window into his arms. They had to have their romances, even then! Mother was only fifteen and her worldly goods and chattels were tied up in a shawl. Father had his entire estate in his trousers pocket—the savings of his army service.

This, then, is something about my parents—hardy, fighting pioneers—square-jawed, sturdy, patriotic folk, who were not in the habit of asking odds.

The Goat Man.

I was born in a house on East Main street, Ft. Wayne, Indiana, March 26, 1870. Father was employed by Hoffman Bros., millwrights. During my baby days, father was moving about a great deal, following his job. He finally settled in St. Louis, where I had my first public instruction in the old Henry Ames school. Father was superintendent of Liebke & Schrage Lumber Company's immense saw mills, but the work was too much for his failing health, due to army exposure, and he resigned there and traveled into the west. I have never found any story quite so pathetic as the diary he kept for mother in his meanderings through Kansas and Nebraska in 1878 and 1879. He wanted to live and his wasting body told him all too plainly that he could not. He returned with his family, now grown to five—two boys and a girl—to a farm in Kosciusko county, Indiana, where he died in the winter of 1881. He was buried in the little cemetery at North Webster, Indiana, where the weeping willows brush the top of his grave and where his survivors gather to do honor to his memory. He left a small amount of insurance to his widow and her children.

Mother put this money into a small farm of barren soil and we all went to work. I remember the place as being the original locust center of the universe. The seeds had fallen from the trees and they all took. I grubbed locust shrubs from morning till night and got more benefit from the exercise in a week than Doc. White can deal out at the Illinois Athletic Club in a season. Well, somehow we got along, but it was hard work and long days and mighty poor going. In the winter I went to the district school and put discipline on the bum. At St. Louis I had to toe the mark. In the country I would do everything the bigger boys did, only to take my licking for an example to the smaller children. I have always managed to get in dutch, and I started early.

I graduated from the grades at Leesburg, Indiana, when I was eighteen. Prior to that I had traded a pair of skates for a printing press; made my own type cases and a lot of type; supplementing the little fonts I had been able to buy.

My first publication was an amateur journal, which I called *The Monitor*. There were four 3 inch by 4 inch pages, done one at a time on my little press. I bought the paper of the grocer and cut it on Deacon Baxter's tinner's shears. The whole edition, wrapped and ready for mailing, weighed less than a pound! The only subsidy I enjoyed was a second-class entry for that little sheet. Newspaper men will please make a note.

In 1888 I moved to Alma, Nebraska, where I set up a little shop to print amateur papers for amateur journalists. I did work for Finlay Grant in Nova Scotia and for F. L. Flanders, Jr., in Coronado Beach, Cal., and for Louis Kempner in New York and Howard M. Carter and John L. Tomlinson in Chicago. The town of Alma never knew I was there for a year

after I arrived. Finally the citizens began to ask me to bid on job printing. I told them if they wanted me to do the work to leave it and I would send them a bill, but I wouldn't cut prices. After a while this doctrine won favor. Alma was kind to me. My job printing business grew and later I leased the old *Harlan County Times* and sued all the delinquent subscribers. I got in dutch, right there. I had farmers hauling me quaking asp cord wood that they must have needed themselves. After my lease of the *Times* expired I started the *Alma Weekly Record* and conducted it as a republican newspaper in a farmers' alliance, populistic community. It was in Alma that I met and afterwards chummed and lived with George A. Briggs, now president of the Chicago Telephone Supply Company and Briggs Electric Company at Elkhart. Briggs was cashier in his father's bank at Alma and after two years' association with him I was able to borrow some money! Briggs was useful to me in those early days and he is responsbile for my entrance into telephone affairs.

I lived in Alma for eight years when I moved to Hastings, Nebraska, and established the *Hastings Daily Record*. My connection with the *Record* lasted two years, when I sold it and went to Omaha. I accepted my first job at Omaha and depending upon the fortunes of a pay envelope I married Miss Estelle R. Long. My position was that of superintendent of the Western Newspaper Union.

Meantime I had kept in touch with my old chum, Briggs, and he had been telling me of his tremendous success as a manufacturer of independent telephone apparatus. He visited me in Omaha and wanted to know if I would accept a place with his friend Harry B. McMeal, publisher of *Telephony*. It was arranged that I should come to Chicago and look into the proposition, which I did. When I came to Chicago to look over the prospect, Frank G. Jones and Charles L. Johnson owned an undivided half of the property. Frank Jones looked me over at Briggs' quarters in the Palmer House and said he thought I would do. The record will show that my name was pinned to the mast-head of *Telephony* in its issue of July, 1902. I came in as business manager and retired five years later, as secretary-treasurer and a tenth owner. McMeal and I never agreed on policy. He wanted the dyed-in-the-wool, simon-pure brand of independent doctrine and being the main works, I was kicked out with my notions when he got ready to administer the kick.

I was in debt for my *Telephony* stock, but I managed to pull myself together, hock my chips and whetstones, get my friends to endorse notes with me and by these methods, I bought *Sound Waves*—a telephone paper with a record as crazy as its name.

I managed to build up *Sound Waves* till it had the business and dignity to interest James H. McGraw, who thought he could do a better job in conducting it than I could. But while Mr. McGraw was plotting to buy, I was incurring the displeasure of every independent telephone manufacturer by carrying the advertising of the Kellogg Switchboard & Supply Company. No need to dwell on this painful subject. I was the goat man then as I am now. Independent manufacturers put me in an inquisition chair and told me to remove the objectionable advertising or accept their cancellations. I stuck for Kellogg. I lost every independent account. Kellogg's attorneys took my deposition and the letters of cancellation and were submitting the whole dirty mess to the United States District Attorney when I went to New York and sold *Sound Waves* to James H. McGraw.

Mr. McGraw merged *Sound Waves* with *The American Telephone Journal* and promised to conduct a broad-gauged, impartial, fair-minded, constructive journal. I was retained on a temporary basis. But Mr. McGraw's policy for his new paper was short-lived. He fluked when the old sentimental crowd swooped down upon him. I turned in Kellogg's $3,000 advertising contract and the gang who started in to do me insisted that Mr. McGraw should fire out the Kellogg advertising. They would have nothing of his paper unless he complied. The sorry spectacle followed wherein a millionaire publisher turned turtle. Mr. McGraw returned the Kellogg advertising.

I liquidated a part of my debts with the money received from Mr. McGraw and when he sold his telephone experience, I started Telephone Engineer. It has always been my notion that the telephone business is excelled by no other business. It has stood for more extravagance in mismanagement than any other industry. In establishing Telephone Engineer upon the platform laid down by Mr. McGraw, I was only carrying out my original idea. Mr. McGraw having sold his publication, I was free to exercise my belief. I wanted some more of the old fight. There isn't anything in any industry half so interesting. There isn't a hope of finding a condition that will present so many fool sides. Independent manufacturers say they will not advertise in a telephone paper that carries Bell advertising. Since Telephone Engineer was established I have had these Independent telephone manufacturers—Kellogg Switchboard & Supply Company, Stromberg-Carlson Telephone Manufacturing Company, Ericsson Manufacturing Company and Monarch Telephone Manufacturing Company, all of whom came in and went out, just for the thrill it would give 'em to try the experiment. Some day they'll all be back with the rest of the survivors.

I have wanted to tell you about myself for a long time, because you don't know how thoroughly I enjoy a scrap. Jim Parish used to drive his horse into my office just to tell me that if he had my chin, he'd sign the pledge. Mother named me Eddie, which is just one peg removed from Percy. When I grew up a bit I dropped the second syllable. Father named me Judson, but I hated Jud as a nickname and never let the kids know what the J stood for. When my wife got her calling cards, Ed looked so hard she named herself Mrs. Edgar Judson Mock. I call it my society name—a joke that Jim Wakeman never forgot.

So there you are. I am forty-one, going on forty-two. I am a member of the Illinois Athletic Club; Normal Park Lodge, 797, A. F. & A. M., and Hastings Lodge, 28, K. P. The picture I show was made for Theodore Gary, four years ago, but was never used. I am the original trouble-maker in the minds of a few telephone men who simply skin themselves in trying to skin me. I have enough stuff up my sleeve to run Telephone Engineer for forty years and my health is bully!

The legislature of Maine has under consideration a bill providing for a public utilities commission of five to take the place of the present railroad commission.

The Law and the Telephone

By E. J. Wenner

TELEPHONE COMPANY REFUSES SERVICES—BACK RENTAL CLAIMED FROM SUBSCRIBER—NO RIGHT TO DISCONTINUE SERVICE.

THE case of Danaher v. Southwestern Telephone and Telegraph Company, originally tried in Little Rock, Ark., and later appealed to the Supreme Court, and reported in 127 *Southwestern Reporter*, page 963, decides that a telephone company cannot refuse to serve a patron who has offered to comply with its reasonable rules and regulations, even though the patron is indebted to the company for services rendered in the past.

Mrs. Adelia Danaher alleged defendant liable to her in a penalty of $100 per day for forty days, and claimed that on March 30, 1908, her service was discontinued and not resumed until forty days thereafter. She alleges that during this time she had paid her regular and proper rental to the defendant company and had complied with all its reasonable rules and regulations. She claims further that during the same period of time defendant furnished services to others under like circumstances which constituted a discrimination against plaintiff such as to entitle her to recover the penalty prescribed by law.

The defendant alleged that plaintiff was indebted to it in the sum of $2 for services rendered during some previous month, and that though plaintiff claimed to have a receipt showing the payment of this amount, yet she failed and refused to produce it and had repeated notices that her telephone service would be discontinued if she refused payment.

In deciding that the original case should have gone to the jury the court made use of the following language:

"The telephone company in devoting its property to a use in which the public has an interest becomes a public servant and is bound to serve the public impartially. It is like common carriers, in that it is bound to serve those applying to it impartially and upon equal terms.

"A telephone company, being a public servant, cannot refuse to serve anyone of the public in that capacity in which it has undertaken to serve the public, when such one offers to pay its rates and comply with its reasonable rules and regulations. It cannot refuse to serve him until he pays a debt contracted for services rendered in the past. For the present services it has a right to demand no more than the rate of charge fixed for such services. It transcended its duty to the public when it demanded more. State ex. rel. Gwynn v. Citizens' Teleph. Co., 61 *S. C.* 83, 55 *L. R. A.* 139, 85 *Am. St. Rep.* 870, 39 *S. E.* 257; Nebraska Teleph. Case, supra; State ex. rel. Payne v. Kinlock Teleph. Co., 93 *Mo. App.* 30 *L. R. A. (N. S.)* 349, 67 *S. W.* 684; Jones Teleg. & Teleph. Co.s Sec. 251, and cases cited.

A tender or payment to the telephone company of its rate or charge for service or rent of telephone for any particular time, and an offer to comply with its reasonable rules and regulations, would entitle the applicant to such service. Should the telephone company incur a penalty by refusing to rent or render such service, it could prevent the increase thereof by renting or offering to rent the telephone, or rendering, or offering to render, the applicant such service."

In the case of Cumberland Telegraph & Telephone Co. v. Hobart, 89 *Mississippi* 252, it was decided that a telephone company may refuse to furnish service to one who will not pay for it and that a regulation that in case a patron is in default service will be denied is reasonable and may be enforced. In this case there was no evidence showing a discontinuance of service on account of past due bills.

In the case of Rushville Co-operative Telephone Company v. Irvin, 59 *Northwestern Reporter* 327, the court held as above and stated that the reason for the rule is that the law compels a telephone company to furnish efficient service without discrimination under reasonable regulations and since it can maintain an efficient service only through prompt payment of its dues and tolls, the use of the summary remedy is reasonable.

This last above mentioned case also decides that telephone service may be refused for non-payment of rental even though the company is indebted to the subscriber.

The reasoning of the courts is that where there is a dispute between the company and the subscriber over indebtedness the remedy of the patron is to pay under protest the amount demanded and sue for the excess.

The courts also hold that a telephone company cannot be the judge of indebtedness and refuse to furnish services to enforce payment of disputed bills Goodwine v. Cadwallader, 172 *Indiana* 619; Payne v Kinlock Telephone Co., 93 *Missouri Appeals* 349.

In the case of Webster v. Nebraska Telephone Company, 32 *Northwestern Reporter* 237, in which the company refused to install service for one who had previously refused to pay rental because no directory had been furnished him, it was held that the subscriber had a right to service if he complied with the reasonable requirements of the company. The telephone company contended that because of unpaid indebtedness for services rendered in the past they were not obliged to install a telephone for him.

The court said that "The mere fact of a misunderstanding with those who desire to receive its benefits will not relieve the company from the discharge of its duties; that if the relator was indebted to the respondent for the use of its telephone the law gives an adequate remedy for the amount due."

In the case of Payne v. Kinlock Telephone Company, cited above, where the company refused to restore a telephone until the subscriber paid for back services, the court made use of the following language:

"Without deciding whether a previous failure to pay the rent, either from dishonesty or inability, would justify a telephone company in refusing to again install an instrument removed on account of the default until it was made whole for the back rent

and cost of installation, we do decide and hold that when the customer is solvent, and it is fairly doubtful if any back rent is owing, or, as in this case, when the subscriber has paid for all the service he got (and there is practically no testimony that these appellants owe anything, while they are shown to be financially responsible), a company cannot insist on that condition—cannot be judge in its own case and decide the dispute."

EMPLOYE INJURES TEAM—DAMAGES SOUGHT BY OWNER.

J. M. McDonald brought suit in the District Court of Woodbury county, Iowa, against the Iowa Telephone Company for $300 damages. The plaintiff alleges that an employe of Iowa Telephone Company hired his team and that while same was in his custody it became injured, and because of such injury defendant is responsible in damages.

The action will be decided shortly.

Comparing American and English Service

In the London *Daily Mail* T. F. Purves, an engineer of the British General Post Office, who, with several other officials of the post office and the British telegraph and telephone services, has been investigating telephone service in the United States, says:

"The telephone service is distinctly smarter in the large towns of America than it is with us. Since I came back the local London service has seemed more irritatingly slow than it did before. We have plant and equipment practically identical with those of New York or Chicago, yet the result in speed of service is not as good.

"As regards long-distance service, general statistics show that the average delay before a trunk connection can be obtained in England is not very much greater than it is in America. Their superiority is principally in communication between large cities, and in this respect it is indisputable. The explanation is simply that the trunk lines between principal cities are provided upon a much more lavish scale than has been done in this country. Consequently the American rates are two or three times as high as those of the British Post Office for conversation over the same mileage. The trunk service is relatively much less used in America than it is here. The small man over there cannot, because of the price, afford the luxury of much long-distance telephoning.

"On the point of quality of speech transmission, if anything the balance is in our favor. Our lines are more carefully constructed. I had many long-distance communications and as a rule I found communication above 400 or 500 miles was not at all easy. There are some specially good lines between important cities over there, and if one is lucky a very fair talk may be obtained between New York and Chicago—950 miles. My colleagues and I were among the first to make trial conversations over a newly completed heavy line between New York and Denver, more than 2,000 miles. The result of our trial was poor, but the weather had been stormy.

"The majority of telephone engineers are very much disposed to believe that automatic machines are destined to play a great part in the telephoning of the future. At the present time there are not fewer than 250,000 telephones working through automatic exchanges in the United States. At the present moment in Chicago an automatic system is being installed for 80,000 subscribers in eight exchanges of 10,000 lines each.

"On the principle of 'trying it first upon the dog,' an automatic exchange is to be installed at the General Post Office, and tenders for its construction have been invited, and afterwards automatic exchanges are to be tested in the provinces."

Using Old Telephone Directories

A unique advertising proposition for Oklahoma City has been worked out by H. G. Eastman, assistant secretary of the Chamber of Commerce, the material for which will be 9,000 old telephone directories which were gathered up by the Pioneer Telephone Company. New directories were issued at the same time. The Pioneer company will co-operate with the Chamber of Commerce in placing the old copies in every city and town over the state.

The old copies really are not out of date, since they were issued last spring. The company will send one copy to the manager of each branch office in the state, which number 1,600, to be placed on file in the office. In addition other copies will be sent, to be distributed among the business houses.

The advertising for Oklahoma City is secured in the fact that whenever the merchant desires to order goods, or one of his customers desires something for which it is necessary to send out of town, that directory will give a list of all business men of Oklahoma City who have telephones classified according to the business. This includes practically all of them.

If there are not enough of the books to place one in each prominent business house in each city and town of the state from those which are gathered up now, the work will be completed when the next new directory is issued in two or three months. Later the ones sent now will be replaced by newer books.

Mr. Eastman suggested the plan to the Pioneer company and its officials took up the idea heartily. In addition, Mr. Eastman asked them for 500 copies from which the lists of classified firms can be clipped, to be sent out-of-town inquirers. Hundreds of inquiries are received by the secretary, asking for a list of the hotels, loan companies, real estate men or other class of firms in the city. The list not only is complete, but gives the street and telephone number of the parties regarding whom inquiry is made.

In the past the Pioneer company has been burning the old directories.

Telephone on Church Spire

The new Episcopal Cathedral of St. John the Divine, at New York, which was dedicated April 19, contains a complete system of telephonic communication.

Every part of the mammoth building is linked to every other part through a central switchboard.

There is a telephone on the highest point of the dome. Another will be placed at the top of the spire, more than 400 feet above sea level. There are telephones in the choir stalls, while another instrument is at the elbow of the organist.

The telephone system extends to the synod hall, where the canons have their offices, and to the choir school.

Copper Clad Wire in Municipal Service

By Warren E. Fastnacht *

THE prime requirement in a municipal fire alarm system is reliability of service at all times. It makes no difference how good the box equipment may be, or how well the office at headquarters may be equipped, if the outside lines are not so strong and durable as to successfully resist the worst weather conditions. If a line conductor breaks, it interrupts the whole system and also puts out of commission the particular circuit on which the break occurs, until a lineman can go out and find the trouble and make repairs. Such an occurrence may disable a portion or the entire system for a day or more and is very undesirable, especially when the increased fire risk is taken into account.

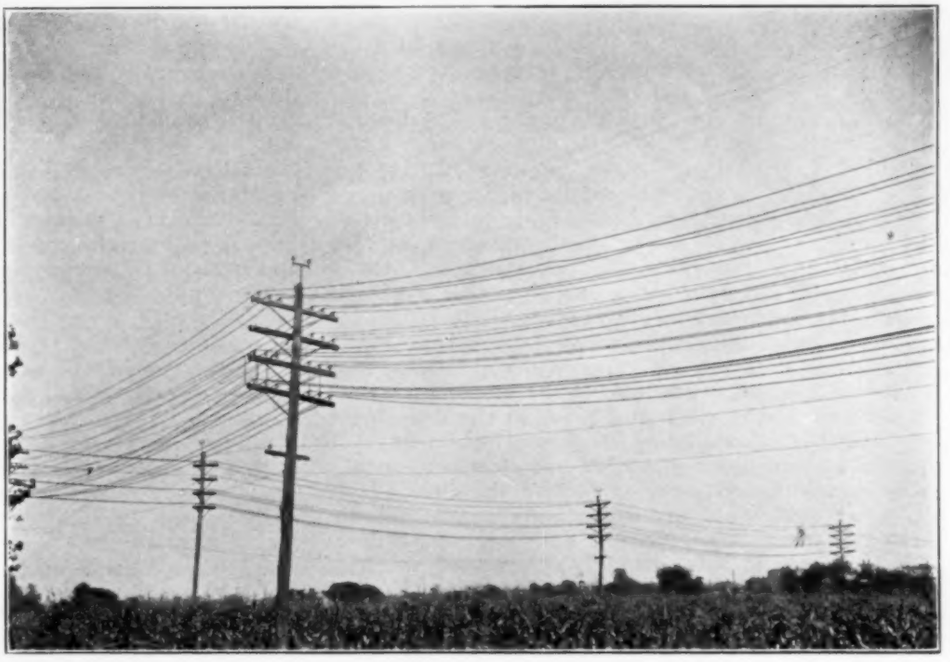


Fig. 1.

The general efficiency of fire and police systems is measured by the total number of hours in each day, and the total days in each year, during which they can give absolutely continuous service. Reliability is, therefore, a prime consideration and this means, in overhead work, that wires and cables must have ample tensile strength, with a reserve or margin to insure safety.

In the early days, soft drawn copper and iron were the only materials available in the form of wire, but the poor tensile strength of copper and the poor conductivity of iron made neither one an ideal material. It was recognized very soon that if the high conductivity of copper and the high tensile strength of steel could be combined in one wire, the result would be a perfect conductor for overhead lines. This led to many attempts to use bimetallic unwelded wires of copper and steel, with the numerous failures whose history is well known.

While these attempts were going on, hard drawn copper was discovered, and it seemed for

Fig. 2.

*City electrician, York, Pa. Paper read at Atlantic City convention of the International Association of Municipal Electricians.

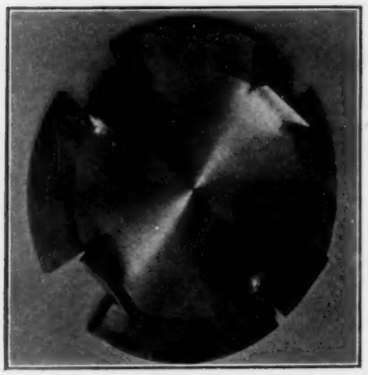


Fig. 3.

a time that the problem was solved. Experience shows, however, that it was not solved, and we know today that there is a very large field for a wire of greater tensile strength. A few years ago, I learned that a successful method of welding copper and steel had been discovered and I looked into it very thoroughly. This wire material is known today as copper clad steel, and I will describe briefly how it is made.

A billet of mild steel is specially prepared and centered in a mould, so arranged that the billet can be lowered out of the bottom of the mould by means of a rod from which it is suspended at the top. After preheating, the steel billet is lowered into a very hot bath of molten copper-iron alloy and allowed to remain long enough to alloy the surface of the steel. It is then withdrawn and the entire billet and mould are immersed in a crucible furnace containing pure copper. After the mould fills with copper, which pours in through openings at the top, the whole is withdrawn and allowed to cool. Then the mould is removed and the finished billet of copper clad steel is reheated, rolled to rods, and drawn to wire. During the entire process, the copper adheres firmly to the steel and the proportions of copper and steel remain the same from billet to wire.

Having satisfied myself that this wire was welded, I obtained, several years ago, about 300 feet of No. 12 B & S and had it erected where I could watch it, through one entire winter. The results proved to me that it possessed in service the actual properties which the tests showed it to have, and we are satisfied that it is far superior to any other wire for fire alarm and police service. We now have nine miles of No. 12 in use in York, on the fire and police systems, most of which was used to replace No. 10 B & S copper on lines running east and west, which were the most affected by storms.

The accompanying photograph shown in Fig. 1 shows some of our No. 12 copper clad lines taken during the past month, from which it is apparent that they are as taut as when first strung and were not affected by the severe tests of the past winter. The photograph in Fig. 2 shows how No. 10 copper lines were affected during the same period, and exhibits the slack condition they were in after the winter season.

The cost of our change from No. 10 copper to No. 12 copper clad was very largely offset by the sale of the old No. 10 at its scrap value. The No. 12 copper clad is not as heavy and was installed with great ease and facility. It can be handled much more readily than copper, which is very likely to break at a small scratch or nick in the surface, while copper clad does not.

I have shown in Table 1 the tensile strength and resistance of copper and copper clad for No. 10, No. 12 and No. 14; also the weight per mile, for bare wire. Copper clad weighs about 7 per cent less than copper, and is about 60 per cent stronger and has 40 per cent of the conductivity of copper in the regular grade.

TABLE I.

	Weight per Mile		Breaking Weight		Resistance per Mile	
		Copper		Copper		Copper
Size—	Copper	Clad	Copper	Clad	Copper	Clad
No. 10	166.	154.	489.	800.	5.5	13.7
No. 12	104.	97.	307.	510.	8.7	21.8
No. 14	66.	61.	193.	330.	13.9	34.9

The weights of double braid weatherproof per mile, I have given in Table 2.

TABLE II.

	Weight of D. B. W. P.	
		Copper
Size—	Copper	Clad
No. 10	258	229
No. 12	158	151
No. 14	106	102

In most signal systems, the size of wire is based on its tensile strength only. For example, No. 10 copper is used for overhead lines, while No. 16 copper is ample for the same kind of service underground. The strength of No. 12 copper clad exceeds that of No. 10 copper by at least 4 per cent, while its elastic limit is 50 per cent greater. The resistance of No. 12 copper clad is about four times that of No. 10 copper, or

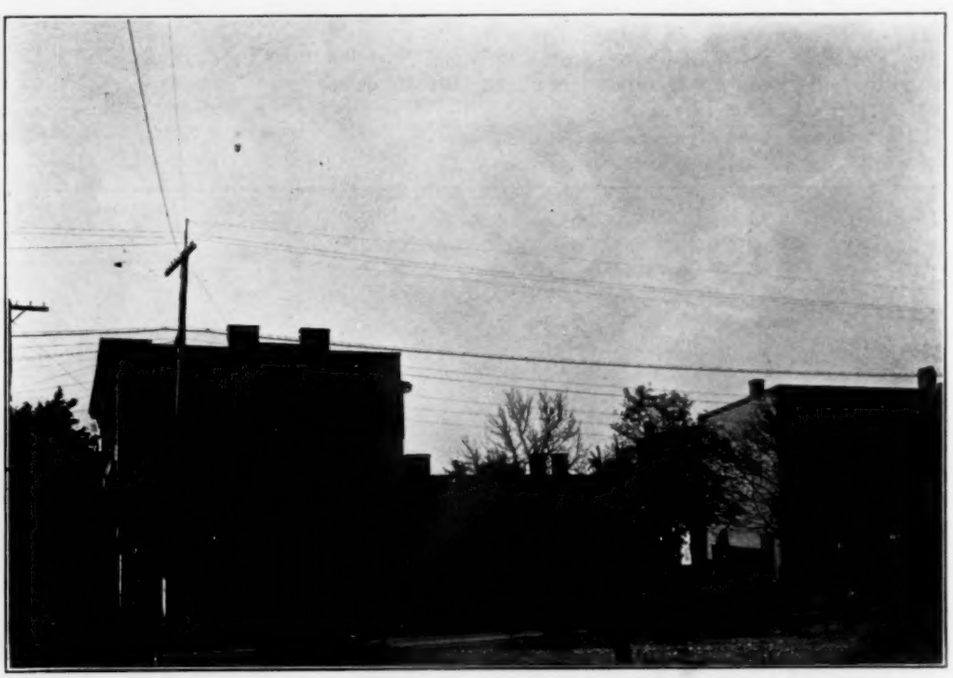


Fig. 4.

about equal to No. 16, but our experience shows that the resistance factor is unimportant, in comparison with the gain in tensile properties and the reduction of cost. The higher elastic limit is an important advantage because the wire will not stretch under conditions which will cause considerable permanent increase in the sag of copper. This sort of thing reduces the life which copper ought to have—and would have if it possessed more strength. For this reason copper clad can safely be assumed to have a longer life than No. 10 copper, and much less annual maintenance cost, due to avoiding breaks and slack.

The copper coating of copper clad protects it against corroson fully as much as a solid copper wire, and on account of the weld there is no fear of corroson at the junction of the metals. The examination of the weld under a microscope shows that there is an "alloy film," composed of copper-iron alloys which unite the copper to the steel. This is shown in Fig. 3, which is the photomicrograph of the polished end of a copper clad wire. The test of the weld is readily made by breaking the wire in different ways and by hammering it; also by heating it to a dull red and plunging it into ice water. None of these tests will separate the copper and the steel in copper clad.

No. 12 copper clad will stay up in a storm longer than No. 10 copper for three reasons. First, it has more strength; second, it has a higher elastic limit; and lastly, it has a smaller diameter to catch wind and sleet. The value of this insurance against service interruptions is very important and alone justifies the use of copper clad, even if it should cost more than copper—although it does not. The extra battery cost is not significant in comparison with the many advantages which are secured. In many cases, the experience would no doubt be like that we have had in York, where the old lines have been spliced and patched in hundreds of places, the conductivity of many of these joints being so low that new No. 12 copper clad would measure lower in resistance.

Our results were obtained by running the new wire from box to box without any joints and soldering the ends to the box leads. By dead-ending at each end of the section and using the Bell Company's form of tie, which does not cut or kick the wire, we have ideal construction.

In York we place our fire and police wires on three-foot iron extension arms above all the pole tops, fastened with through bolts, which makes a rigid construction. This permits us to pull our wires up as taut as is safe to have them and where they are copper clad they remain that way. The box leads go down the poles in galvanized iron pipes, each equipped with an insulating joint before reaching the box. This practice reduces our chances for the occurrence of grounds. When police and fire alarm wires occupy the same pole, we use three and four-way extension arms, and one of the photographs, Fig. 4, shows the difference between No. 10 copper police wires and No. 12 copper clad fire alarm wires put up at the same time.

The saving in maintenance costs we find is an important item, and if we could have secured copper clad years ago, our total savings would now be very considerable. Even if we should use No. 10 copper clad in comparison with No. 10 copper, there would still be a saving in cost and a tremendous gain in reliability. We have not had a single break or case of trouble on our copper clad lines since they were installed. Last winter we had the most severe snow and sleet storms in years and No. 10 copper lines were down in all directions, but our No. 12 copper clad was not affected at all. After the sleet and snow melted, it became as taut as before.

The extra strength of copper clad also helps to hold up the pole line and this is no small advantage, especially when such wires are up at the tops of the poles where they can do the most good. The local telephone companies whose poles are used by the city appreciate the extra strength of copper clad and have advised us to this effect. The telephone companies themselves are also using the wire, and the York Telephone Company has had eighteen miles of No. 12 in service for several years without one case of line trouble.

Probably the best evidence of the result of our experience with the use of No. 12 copper clad is contained in the fact that the fire committee have decided, after witnessing our tests which extended over some three years, to replace all the No. 10 copper in the York fire alarm system with No. 12 copper clad. We are convinced that this is not only economy from the standpoint of direct cost, but it will reduce our maintenance and much improve the reliability of our system.

Telephone on a High Tension Transmission Line

The transmission line of the Southern California Edison Company is carried on steel towers, of which there are 1,013. These range in height from forty to sixty feet. The total length of line is 117 miles, making the average span 700 feet, says a writer in the *Electrical Review and Southern Electrician*.

A telephone line extends the full length of the transmission system, being supported on the steel towers. The telephone line is transposed at every tower. Considerable difficulty was experienced in balancing the telephone system, and the scheme adopted was to install two thousand 110-volt transformers, connecting the high-tension side across the line at each instrument and grounding this coil at its middle point. The telephone line is sectionalized and is provided with switches, so that if any section is out the instrument at the next section is protected by the interposition of a balancing transformer. That is, a section cannot be disconnected without switching a transformer into its proper position with the telephone instrument being used. The construction of the switch is simply that of a blade which recedes from one clip and enters into another connecting the transformer into the telephone circuit, as above mentioned.

It may be stated here that most of the interruptions on the transmission line have been caused by large birds. In a few cases the line conductors have been burned off, and service temporarily crippled. Everything considered, this line has given good service, and has been very reliable.

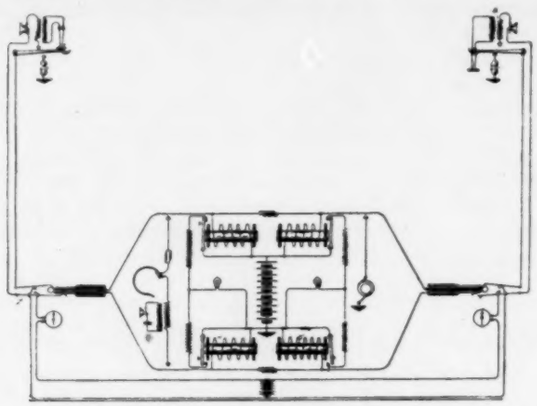
It is announced that the establishment of direct telephonic communication between Berlin and Stockholm is impending, if it is not already an accomplished fact, by the use of the Egner-Holmstrom microphone. The trials with the apparatus in question are declared to have been successful. Telephonic messages have been exchanged between Stockholm and Hamburg for a long time past, while Berlin is already able to communicate with nine Swedish towns.

Recent Telephone Patents

By David S. Hulfish

991,583. Atachment. Charles L. Williams, Parkersburg, Va. The novel feature is found in means for supporting the receiver at the ear of the telephone user. A desk stand is provided with a lazy-tongs attachment for holding the receiver, the hookswitch contacts being operated by the movement of the lazy-tongs; the device is built integrally with the body of the desk stand, rather than as an attachment.

991,590. Electrical Switch. Joseph L. Wright, Washington, D. C., assignor to North Electric Company, Cleveland, Ohio. An economical arrangement mechanically for a row of mutually



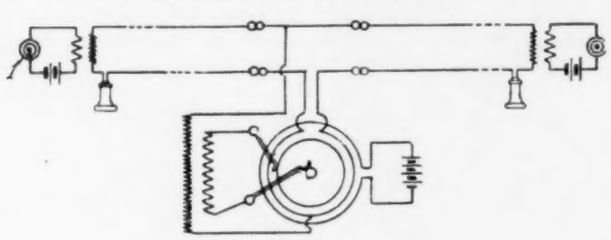
991,654.

locking keys. One locking plate is provided, the depression of any key unlocking all others and locking itself. A guide pin also is guided by the locking plate.

991,654. Common Battery Switchboard Circuit. Newton C. Shellenger, Chicago, Ill., assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester; N. Y. Application filed in 1901. The cord-pair is of the four-relay type, the two relays of the live sides of the two lines being held by current over the live wires of the lines through low-resistance ringers to ground after the telephones have been hung up, the clearing lamps being illuminated by the back contacts of the relays of the dead sides of the lines and the front contacts of the live side relays. A two-wire pack without multiple is shown.

991,829. Relay. E. E. Clement, Washington, D. C., assignor to North Electric Company, Cleveland, Ohio. A relay having a pair of spools is constructed with its armature and contact elements arranged upon the plan of the well-known single-spool return-pole relay.

991,928. Telephone Repeater or Speech Relay System. Charles G. Ashley, Chicago, Ill. The relay or wave amplifier is



991,928.

of the dynamo type, received speech currents being accepted by a field coil or equivalent and amplified currents being delivered by the armature or equivalent. The novelty is found in so connecting the circuits that the field coil is differential to the armature currents, whereby the amplified armature currents do not again affect the field, thus avoiding "singing."

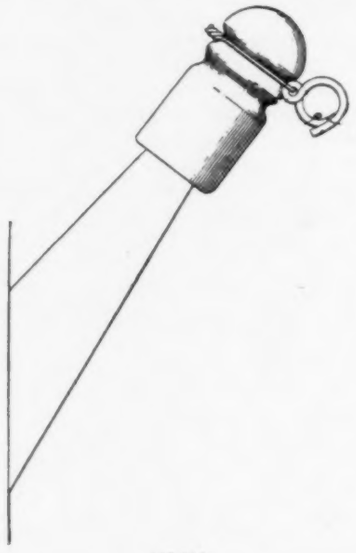
992,165. Telephone Switchboard System. Henry P. Clausen, Chicago, Ill., assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. The object is to avoid the expense of cut-off relays for the lines of a lamp-signal switchboard. The helix of the line relay is shunted out with a low-resistance supervisory relay in the cord pair.

992,333. Automatic Telephone Exchange System. Alexander T. Brown, Syracuse, N. Y., assignor to Wilbert L. Smith, trustee. Filed May 25, 1895, renewed July 16, 1910. A complete system of selecting switches and circuits is shown, including power-driven switches in the central office controlled by the armatures of magnets whose windings are in the circuits to the substation. The main driving shaft is oscillatory, and the selection rectilinear. Trunk selection is not shown, each line having an individual switch. The patent is of especial interest because of its early filing date.

992,595. Line Support. L. W. Ridenour, Gratis, Ohio. An insulator knob; has a running ring attached with a tie wire.

992,817. Method of Amplifying Electric Currents. Louis W. Southgate, Worcester, Mass. This method may be described as the amplification of wave-form current by means of a dynamo with inductive brushes. The currents to be amplified are accepted by the field coil of a dynamo, are amplified in the armature of the dynamo, and then are transferred from the armature to the outgoing line conductors through stationary windings inductively related to windings carried by the armature.

992,836. Switchboard System. Charles S. Winston, Chicago, Ill., assignor to Kellogg Switchboard & Supply Company, of the



992,595.

same place. A specific arrangement of ringing key, test wire and supervisory signal wires, adapted for operating party line bells upon the circuit of the Kellogg common battery switchboard, which uses one of the talking conductors as a circuit for charging the cut-off relay.

993,046. System for Phantom Adjustment. Frank Fisher, New York, N. Y. The telephone line at the telephone bridge is connected on both sides to ground through resistance and condenser, one or both being adjustable to quiet the telephone and compensate for a varying line.

993,975. Attachment. Charles E. Flynn, Vale, Ore. An attachment for desk stand for supporting the receiver while in use.

994,302. Telephone System. Henry P. Clausen, Chicago, Ill., assignor to Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y. A cord-pair circuit for connecting common battery lines to magneto lines, and in which the transposition of the sides of the pairs is involved.

994,361. Method of Amplifying Telephone Currents. Charles G. Ashley, Chicago, Ill. This is a companion patent to No. 991,928, mentioned above. The claims of this patent cover the method, while those of the earlier patent cover the mechanism of Mr. Ashley's invention.

DEPARTMENT of RAILWAY TELEPHONES

Railway Private Branch Exchanges

By John A. Kick

IN general office buildings, terminal yards, car shops and other points where a number of departments are represented a first-class telephone exchange service is necessary to the prompt handling of business in and between the several departments.

Originally one telephone was installed in the ticket or freight office and the agent expected to answer all calls, acting as a buffer between an impatient public and the railway company; whereas by the present method a private branch exchange, to which all departments have one or more lines, with skilled operators distributing the calls to the departments for which they are intended, avoids the annoyance of receiving calls intended for other departments.

The majority of the railways pay their exchange operators a good salary and as a result secure and retain excellent talent.

Railway officials must keep in touch with the changing conditions of the service, and to this end the p b x acts as "information bureau" and is able, with very few failures, to locate any official upon a few moments notice.

The time saved factor in railway work is of great importance and the p b x has been a substantial contributor to that account.

When an official places a call through the p b x he informs the operator whom he wishes to communicate with, hangs up his receiver and is called back when the connection is complete, thus saving to him the time intervening.

There has been a tendency toward overloading lines leading to these p b x boards, causing heavy code signaling and slow service; but the situation is gradually clearing up, as it has been found that where service is justified good service is desired and can only be obtained by keeping down the number of instruments on the exchange lines, minimizing the annoying waits for an opportunity to use the circuit as well as doing away with the code ring.

Where two or more p b x boards are installed at one terminal they are usually connected by trunk lines, with trunks from one or both to the nearest city exchange; but owing to the great desire to keep down wire mileage these trunks are not always of sufficient number to carry the service without serious delay.

Many old p b x boards are found in dark and dismal corners of office buildings, shops and depots. But a decided change is taking place and recent installations are more carefully made, attention being given to the several features which contribute to pleasant and heathful surroundings and make the positions attractive to skilled workers.

In selecting and assigning a location for a p b x board attention should be given to lighting, heating and ventilating instead of placing the board in some available out of the way corner without consideration for the worker's comfort.

The light on a p b x board should preferably be a reflected, soft tone light, instead of a strong, direct light, which, reflected from the polished surface of the board, injures the eyes of the operator. The angle of the board with respect to the source of natural light, together with the wall and ceiling decorations, can just as well be arranged to produce a pleasing effect.

Out of respect for common good practice the car painter with the can of "standard railroad green" will be barred from the p b x.

If possible terminal racks and cross connection frames should be so located as to be flooded with natural light for inspection and maintenance work, as well as prevention against rats and mice, which are liable to lurk in dark corners and destroy insulation.

All exchange boards should be separated from other departments and maintained as private offices, accessible to no one except in the discharge of duty, as good operating

Department of Railway Telephones

This department is established as a permanent feature of TELEPHONE ENGINEER. The progress of the art of telephone train dispatching, its technical development, its news, and the elucidation of its mysteries for the non-technical worker will be found each month in these pages. The editors invite the problems and solicit the co-operation of the many readers of TELEPHONE ENGINEER in all parts of the world whose interests lie along these lines.

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always needs the undivided attention of the operator.

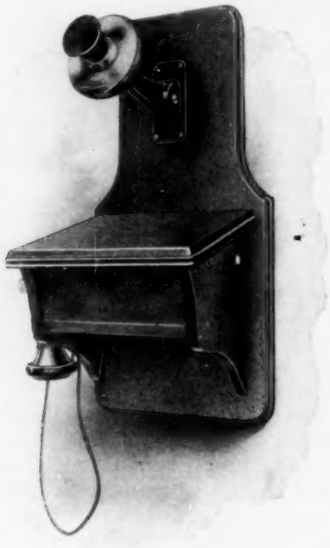
Exchange operators are frequently required to do clerical work, handle telegrams (as phonegrams), and in other ways divide their time. On small exchanges where lines are short and the calls few this division of time of the operator may not be beyond good business policy, but where the exchange is a switching point for important through service or handles a heavy local business the accumulative loss of service, by reason of the operator not being free to give her whole attention to the operating, is considerable and if possible to capitalize would represent many times her salary per month.

The larger p b x to be under the direction and supervision of a chief operator and assistants who enforce the rules of discipline, correct methods of operating and stand responsible to the official under whose jurisdiction the exchange is operated.

Composite Telephone Sets

The telephone, within recent years, has become extremely useful and important in railway work as an adjunct to the telegraph in relieving overloaded telegraph lines. The use of the so-called composite telephone, namely, a telephone that operates simultaneously with the telegraph over a grounded telegraph line, is the most economical method of increasing a wire's capacity.

The No. 1312—A composite telephone, manufactured by the Western Electric Company, is in extensive use where additional wire mileage has been required, and yet the expense of stringing the additional wires themselves was not warranted. For such cases,

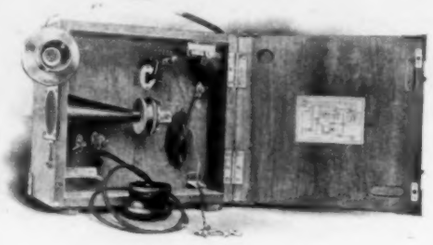


No. 1312-A. Composite Set.

the composite system possesses marked advantages in first cost, operating cost and maintenance. Its installation requires no additional line construction; its operation necessitates no increase in the operating staff, and the absence of outside construction simplifies the maintenance problem. Signaling with a composite telephone is infinitely more effectual than with the telegraph.

The signaling apparatus used with the No. 1312.—A telephone set and No. 1314—A portable composite telephone, calls between stations by means of what is known as a howler. When one operator wishes to call another, he presses a button in the side of the telephone set. This action automatically starts an interrupter working, which sends out high frequency signaling current over the line and causes the howlers at the other stations to give the desired signal in a loud whistle or shriek.

No change in the telegraphic apparatus or its operation is necessary to adopt the system to telephone



No. 1314-A. Portable Composite Set.

operation also. Each telegraph station is merely bridged with a condenser and a resistance and the telephone apparatus is connected between the line and ground. A condenser in each telephone set prevents the telegraphic current from passing through this apparatus to ground.

The sets employ local battery talking, and a condenser is bridged in series with the receiver which itself is shunted by a retardation coil. This coil prevents the telegraphic currents from passing to ground over the telegraph line beyond the telephone station, but does not impede the telegraphic currents, because these are of much lower frequency than those generated by the telephone.

It is easily possible to talk on a composited line of this character while telegraph signals are passing over it, without any interference whatever. The length of telegraph lines over which such service can be given is more or less limited. The most satisfactory operation is obtained where the telegraph is used for through business and the telephone for local business, on the same line. On a short line, service will be better and more stations can be operated than on a long line, and the usual maximum limit is generally taken at 125 miles of No. 8 BWG iron wire equipped with seven telegraph stations and five telephone stations.

On some railroad systems, through lines are composited over different sections, as for instance, in the case of a through telegraph circuit extending from New York to Wilmington, N. C., which is composited between Richmond, Virginia and Rocky Mount, S. C. It can thus be seen that the section of line between these two points is serving a double purpose simultaneously, and thereby saving the expense of installing another circuit between these points.

More Telephones on C. R. I. & P.

The Chicago, Rock Island & Pacific will soon equip its Kansas division with telephone train dispatching apparatus. It has just ordered forty-two Western Electric selectors for a new circuit which will run from Caldwood, Kan., to Belleville, Kan., a distance of 210 miles. The dispatcher will be located in the middle of the line at Herrington, Kan.

Operation and Maintenance

By Richard L. Gilles

IN order properly to maintain the apparatus used in telephone train dispatching circuits, one must have a clear understanding of all the parts used. This article is intended to give a clear explanation of the principles and properties of telephone circuits.

The apparatus used may be divided into two distinct parts, that used for transmission and that used for

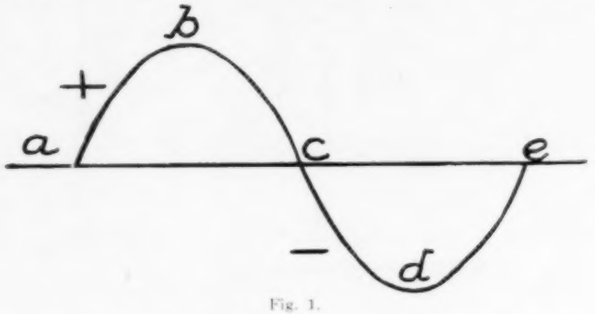


Fig. 1.

signaling. There are two classifications of electric currents, direct current and alternating current. A direct current may be either continuous or pulsating. A continuous current is one which flows in the same direction and has a constant value and would cause a steady current to flow through a circuit having a constant resistance. A pulsating current is one which flows in the same direction, but owing to changes in resistance or voltage the current consists of a distinct series of rushes of current or impulses. An alternating current is one in which the current is constantly reversing its direction, therefore the voltage and the current will alternate between two maximum values. An alternating current is represented by the curve *a b c d e*, Fig. 1. The current will rise to a maximum value *b* in a positive direction and then fall to *O* or *c* and rise to a maximum negative value *d* and then fall to a zero potential *e*. Two alternations, or from *a* to *e*, is called a cycle. Thus 60 cycles a second represent 120 alternations per second. A pulsating current is represented as in Fig. 2.

Here *ab* represents the value of the current, *bc* the length of time of the impulse and *de* the length of time between the impulses. Such an impulse would give a sharp crack in a circuit containing a receiver so that

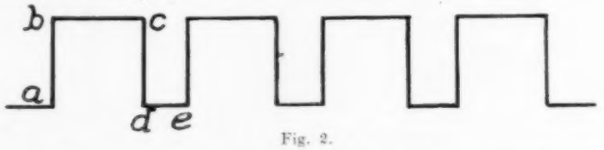


Fig. 2.

means must be used to reduce these sharp impulses to a smoother wave form, which will be taken up later.

The transmission is affected by means of the alternating current, while the signaling is done with the pulsating current; thus it will be seen that the function of the various parts of apparatus is to utilize these currents and divert them to their proper places.

That property which tends to obstruct the passage of current is known as resistance. Ohm's law, in which *E* equals the voltage; *C* equals the current; and *R* equals the resistance, as follows, gives the relation between the various values in connection with direct current or alternating current providing the circuit does not contain inductance:

E equals *C* times *R*; *C* equals *E* divided by *R*; *R* equals *E* by *C*. Thus any value may be determined providing the other two are known.

When a number of turns of wire are wound around an iron core and a current passed through them lines of force are created through the iron which serve to magnetize this core, and when the current ceases these lines of force decrease, and increase again when the current is passed through the turns. This increasing and decreasing of the lines of force set up a current in the coils of wire and the first current's passage will be greatly retarded due to the effect of the counter electromotive force generated in the coils at the time when the alternating current wave is passing through its zero potential.

This effect is known as inductance. The higher the frequency of the alternating current the higher the inductance will be for the same coil. A coil may be wound with a large number of turns on an iron core and have a small resistance to a direct current and a comparatively

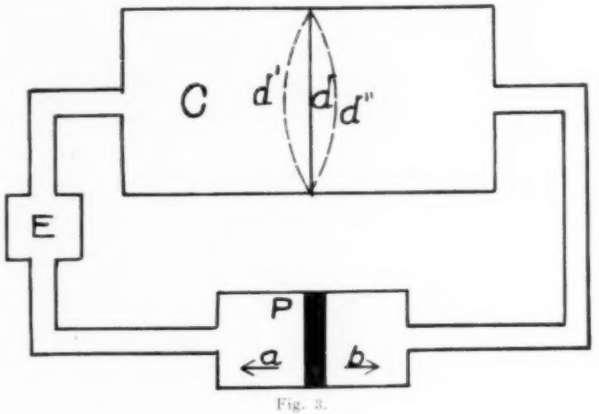


Fig. 3.

large resistance to an alternating current. This is the principle that a selector coil or ringer coil is built on.

Two conducting bodies being placed close together but entirely insulated from each other form what is called a condenser. Commercial condensers are made from sheets of tin foil insulated with waxed paper and wound together in the form of a roll, while condensers are built up from sheets of tin foil and paper. It is a mistaken idea that current flows through a condenser. As a matter of fact it flows in and out of it. When a current is sent in to the terminals of a condenser the plates are charged and when the current ceases or reverses the condenser retains its charge or discharges itself back into the line as the case may be. The action of a condenser may be illustrated as follows (Fig. 3):

Let *P* represent a pump which is constantly reversing its direction of motion and pumping water through the pipes shown, and *C* a cylinder having a flexible diaphram *d*. Now if the pump is working in the direction of the arrow *A* the diaphram will be distorted in the direction *d"* and when the pump reverses in the direction

of arrow *b* the diaphram will be distorted in the direction of *D'*; thus the water will be forced back and forth through the pipes but not actually flowing through the cylinder *C*. If *P* is taken as a source of alternating current and *C* as a condenser and *E* as an electrical apparatus it shows that a current will flow back and forth through the apparatus due to the charge and discharge of the condenser, but not flow through the condenser. Thus a condenser in series with any apparatus will allow an alternating current to flow through the apparatus but will not allow a direct current to flow through it, while in turn a coil having a high inductance will allow a direct curent to flow through it but will not allow a high frequency alternating current to flow through it. The average frequency of the alternating currents in telephone transmission is taken as 700 cycles per second.

A telephone circuit may be said to consist of two parts, the primary and the secondary circuits. The primary circuit consists of the transmitter, battery, and primary winding of the induction coil. The secondary circuit consists of the receiver, condenser, and the secondary winding of the induction coil, in series with the line. This is illustrated in Fig. 4, where *T* is the transmitter, *B* the battery, *P* and *S* the windings of the induction coil, *R* the receiver.

The induction coil consists of a primary winding wound on a soft iron core and entirely insulated from the secondary winding, which is placed over the primary winding; thus there is no metallic connection between the two windings. It will not be necessary to go into the

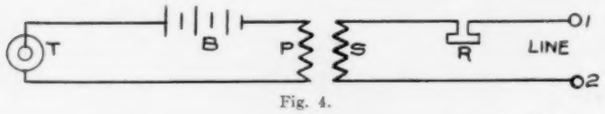


Fig. 4.

construction of the transmitter and receiver. Any vibration of the diaphragm of the transmitter will cause a fluctuation of current flowing through the primary winding *P* of the induction coil due to the changes of resistance in the transmitter, and will set up lines of force through the core of the coil. These lines of force will pass through the secondary winding and set up a current in it corresponding to the current in the primary. The current in the primary will be of a pulsating nature as it never changes its direction, but the current in the secondary will be alternating due to the rise and fall of the lines of force in the core which will cause a current to flow first in one direction and then in the other, because the direction of flow of an induced current depends on whether the lines of force are increasing or decreasing It will be seen that the current from the battery does not go into the receiver or the line but it is the current induced from the primary winding that actuates the receiver. This is the circuit used on a simple telephone, although a receiver hook is used to make the proper connections between the bell and the line, and also to connect the battery.

The circuit used in the Western Electric train dispatching sets is different from the ordinary telephone circuit and operates with a push key as follows:

Fig. 5 shows the key in use and Fig. 6 shows the key in the normal position. *RC* represents a retardation coil which has a high impedance to voice currents, and the transmitter, receiver, coil, and condensers are represented by the letters, *T*, *R*, *P* and *S*, and *C L* and *L* are the line connections and the little arrows represent the connections made by the key contacts. Fig. 5 represents the condition when the operator is talking. The local contacts are closed giving battery to the transmitter and primary winding and the secondary winding is connected to the line through the retard coil *RC*. This coil allows enough current to pass through the receiver so that the receiving party can break or interrupt the party talking, but still does not allow enough current to pass through the receiver from the secondary to interfere with

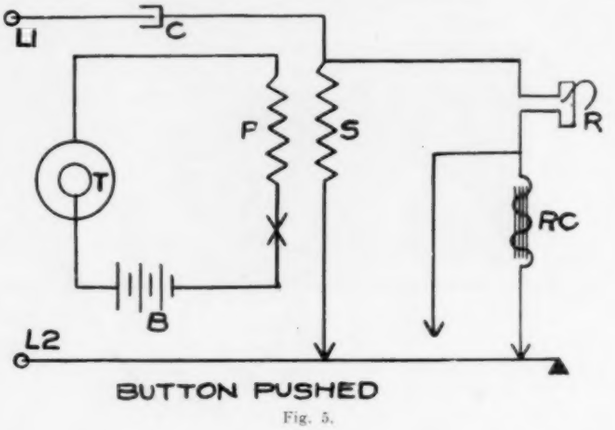


Fig. 5.

the transmission. If it were not for this coil the current would mostly go through the receiver and cause the transmission to be very weak at the distant end. When the button is in the normal position the battery is cut out as is also the secondary of the coil and the retard coil, and the receiver is connected directly to the line through the condenser. This receiver is wound to about 700 ohms resistance and has a high inductance compared to a 70 ohm receiver. This allows it to be connected across the line without shunting out to any great extent any stations which may be listening in. In this way the receiver receives the current directly from the line without being retarded by the winding of the induction coil. The opening of the battery circuit is useful in two ways. It is a saving in battery and it benefits the receiving by not pick-

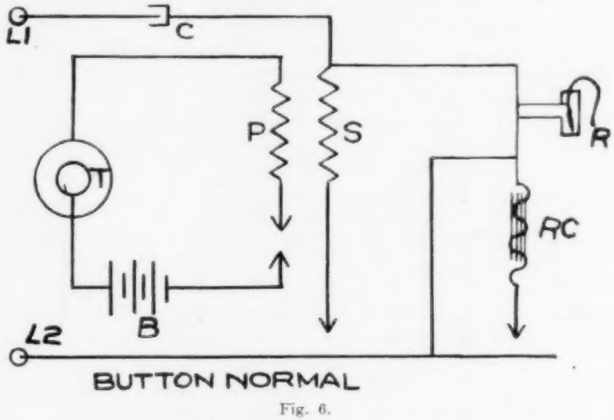


Fig. 6.

ing up the sounds in the room as it would if the transmitter circuit was closed. The condenser in the circuit keeps the direct current used in signaling from passing through the receiver and makes conversation possible at the same time as the signaling.

The Kellogg booster circuit is different from the Western Electric circuit and is shown here in regular (Fig. 7) and schematic (Fig. 8). The retard coils 30*G*

and 30*F* are adjustable so that the incoming currents and outgoing currents can be adjusted so that the end station will average up about the same as the first station out in values of transmission. The pushing of the key closes the local battery contact and shunts the retard coil 30*F* around the receiver and 30*G* coil alone.

The selectors are operated by a set of magnet coils or relays which are wound with a large number of turns of small wire, which offers a high resistance to the high

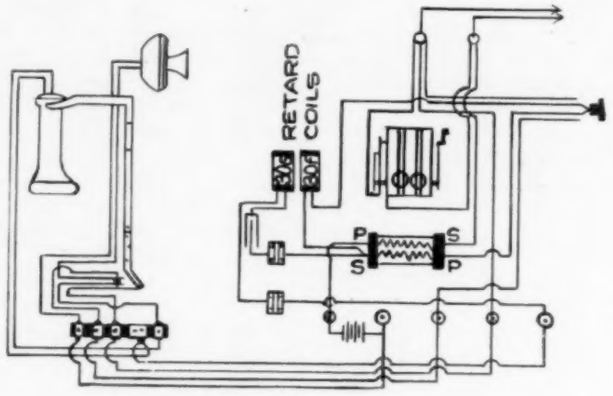


Fig. 7.

frequency voice currents, which allows connecting a large number of these selectors to the line without shorting out the voice currents, as they would if they consisted only of ohmic resistance.

The Western Electric selector consists of four magnet coils all connected in series, two coils being used on the step-up side and two on what is known as the holding side. Each set of two coils operates an armature which carries an arm and pawl which operates the impulse wheel. Each impulse steps up this wheel one notch. The

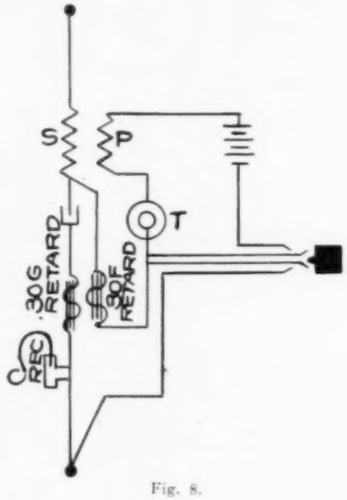


Fig. 8.

holding relay closes and holds its armature up during the impulses so that its pawl will not allow the impulse wheel to fly back. This is accomplished by surrounding the two cores of the holding coils with a copper shell, which serves as a secondary winding of one turn. A current is generated in this coil between the impulses and it in turn magnetizes the core and holds up the armature between the impulses, and does not allow it to release as it does on the step-up side. The Sandwich Electric Company's selector operates on this same principle, but is of a different mechanical construction.

The Gill selector may be called an electro-mechanical selector. This selector is actuated by an electro-magnet and a combination wheel. Each combination wheel has a different tooth cutting so that only the proper number and frequence of impulses will step it up to its contact or ringing position. These selectors are sealed at the factory and are to be returned for any repairs or adjustments. The different styles of selectors are built so that the bell can be operated from the main line battery or from the local battery.

The equipment at the dispatcher's end consists of a main battery for signaling purposes, relays and master selector for sending out the proper impulses and the necessary equipment for transmission.

The dispatcher's telephone consists of a 70 ohm receiver and induction coil in series connected to the line through a condenser ahead of the signaling apparatus. The primary circuit contains a simple key for opening the transmitter circuit. Owing to the low internal resistance of dry batteries used for signaling, they would short the line momentarily during impulses and make it difficult for the dispatcher to hear at the time he was calling someone. This is overcome by using retard coils. These coils have a resistance of 50 ohms each to direct current, but have a high impedance to the voice currents which keeps them out of the battery and diverts them to the receiver. These retard coils are also advantageous in

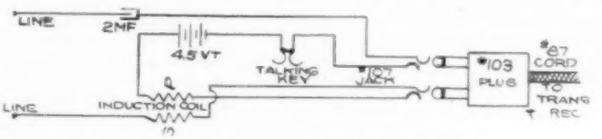


Fig. 9. Western Electric Dispatcher's Set, Schematic.

another way. If the battery impulses were sent to the line direct they would cause a sharp crack in the receivers owing to their peaked wave form, but these coils having a high inductance retard the impulses and smooth out the wave form making the impulses less noticeable.

The master selector is in a local circuit which operates the ringing relays. The contact points on the relays and the master selector are shunted by condensers to reduce the sparking at these points. The Western Electric signaling relay has an additional contact which connects a 250 ohm resistance coil across the line behind the retard coils during the intervals between the impulses. This allows the coils and condensers to unload quickly and not retard the impulses too much owing to their high speed. This contact should be adjusted to break before the battery contacts are closed.

The schematic circuits (Figs. 9, 10 and 11) show the relative connections of the dispatcher's apparatus in the Western Electric and Gill equipment. The Gill apparatus uses two ordinary telegraph relays for sending the impulses to the line. The main calling battery, dispatchers talking battery and local relay battery are all set up in duplicate and provided with double-pole double-throw switches so that the batteries may be alternately used and allow one set to recuperate.

Added resistance is cut in with each selector to reduce the voltage to its proper value. The Western Electric selector is figured to operate on 38 volts and 10 milliamperes or .610 amperes. If the line voltage were 100 volts we would have to cut in enough resistance to

take up the remaining 62 volts which is figured as follows:

R equals *E* divided by *C;* 62 divided by .010 equals 6200 ohms. The main battery voltage is derived as follows (Fig. 12):

Suppose we have a line 50 miles long with five stations each 10 miles apart, each selector taking 38 volts and .010 amperes. The line is 210 pound copper measuring 8.8 ohms per loop mile. This will give 88 ohms resistance between stations. The five stations will require five times .010 amperes or .050 amperes. The first section of ten miles will carry .050 amperes, the next ten miles .040 amperes and so on down to the last section which will carry only .010 amperes. The drop for the first section will be *E* equals *C* times *R* or

.050 times 88 equals 4.44 volts drop. The other sections are,

.040 times 88 equals 3.52 volts drop.
.030 times 88 equals 2.64 volts drop.
.020 times 88 equals 1.6 volts drop.
.10 times 88 equals .88 volts drop.

Adding these up gives a total line drop of 13.04 volts. The resistance of the three 5*L* coils is 150 ohms, 150 times .050 or 7.5 volts drop in the 5*L* coils. The sum of the drop in the line and the drop in the coils is 20.54 volts or the total drop in voltage from the battery to the last selector. The voltage required to operate the selector is 38 volts; adding this to the 20.54 volts drop gives us a total voltage 58.54 required for the operation of the circuit. Figuring a dry cell at 1.4 volts and dividing 58.54 volts by this gives 41.8 or 42 dry cells required.

The drop to the first station would be 7.5 plus 4.4 or 11.9 volts. Subtracting this from the total battery voltage, 58.54 minus 11.9 equals 46.64 volts at the first station. Now the selector only requires 38 volts so we have 46.64 minus 38 or 8.64 volts left over, to take up with the added resistance. The selector requires .010 amperes so the resistance will be 8.64 divided by .010 or 864 ohms of added resistance for the first station. The voltage at the second station will be 46.64 minus 3.52 or 43.12 volts. The added resistance will take up 43.12 minus 38 or 5.12 volts. 5.12 divided by .010 equals 512 ohms. Each station is figured the same way. The last station will have only 38 volts at the terminal so will require no added resistance.

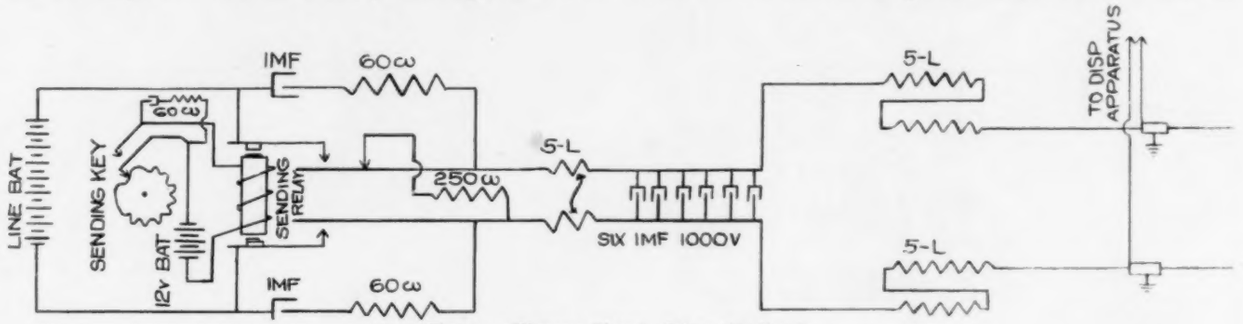


Fig. 10. Western Electric Schematic Circuit.

The added resistance for the bell on a main line selector is taken as 70 per cent of the selector resistance, so for the first station in this case it would be .70 times 864 or 604 ohms.

Every circuit will have to be figured separately and figured in accordance with the resistance of the line, make of selector, etc., but the general rule will be the same as just given.

Transpositions are cut in the lines to eliminate cross talk and disturbances from neighboring wires.

These disturbances may be due to electromagnetic or electrostatic induction. A magnetic field exists about every wire carrying current, and as the current varies so does this magnetic field vary. This magnetic field surrounds the wire the same as a ring does one's finger. If a telephone wire is close enough to a wire carrying current to come within this magnetic field a current will be set up in the telephone wires and flow through the receivers. This is illustrated in Fig. 13.

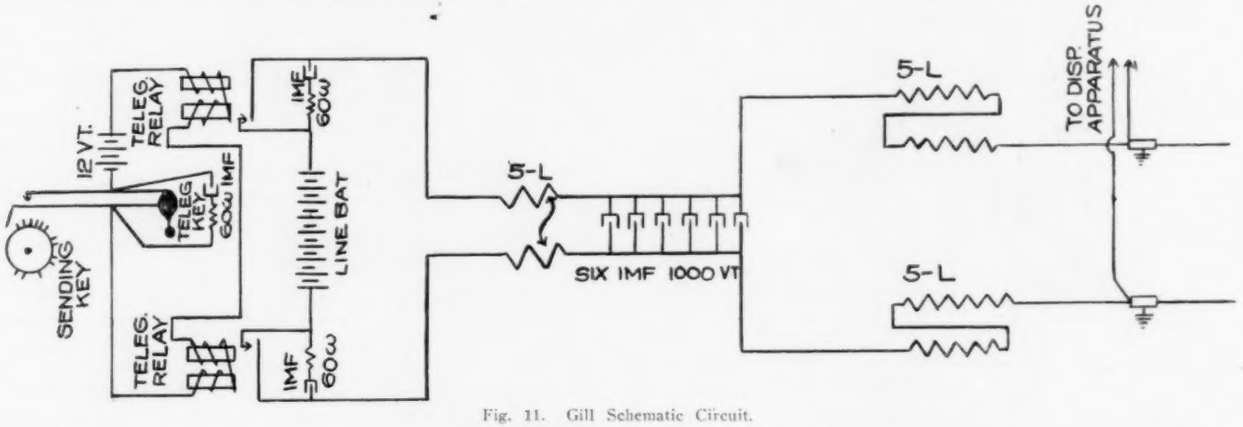


Fig. 11. Gill Schematic Circuit.

Let *A* represent a line carrying a pulsating current or alternating current. As the current varies the lines of force will expand or decrease and cut the telephone wire *B*. This will set up a current in the telephone wire and be heard in the receivers. This would be the condition of a telephone wire running parallel to a tele-

graph wire and is called electromagnetic induction. This condition would set up more of a current in one telephone wire than in the other due to the lines of force being more heavily distributed on one than on the other owing to the distance from the telegraph, and this unequal division of current will cause a flow of current through the receivers. If these two currents were equal and in the same direction no current would flow as they would then be balanced.

Electrostatic induction is a condensor action between neighboring wires. If the neighboring wire is carrying an alternating current it will receive alternate positive and negative charges. These charges will repel charges of the opposite polarity to the telephone wires and these changes in seeking an outlet flow through the receivers and cause a noise in them. Sometimes electrostatic induction takes place to such an extent between adjacent wires that a conversation being carried on over one wire can be heard on the other wire. This phenomenon is known as cross talk.

This is illustrated in Fig. 14.

Let *AB* represent a wire carrying an alternating current with a positive charge, *CD* and *EF* the telephone wires and 1 2 3 4 the receivers at the various places. The wire *CD* will take up a negative charge and the wire *EF* will take up a positive charge. When the charge on wire *AB* becomes zero the positive charge on wire *EF* will divide at the receiver 4 and flow to wire *CD* to neutralize the negative charge as indicated by the arrows. Half of the charge will flow through the receivers *1* and *3* but none will flow through receivers *2* and *4*.

Suppose a transposition to be cut in at the point of receivers *2* and *4*, as in Fig. 15.

This will make the average distance of wires *CD* and *EF* equal from *AB* and eliminate the electromagnetic induction as each wire will now have an equal and opposite charge induced in it. The electrostatic induction will be eliminated as the positive charges on wire *EF* will now have a path to the wire *CD* by way of the transposition and owing to the low resistance most of the charge will pass off this way instead of through the high resistance offered by the receivers *1* and *3*.

It is customary on long lines to make the transpositions one quarter miles or 1,320 feet apart. Where two telephone lines parallel each other the transpositions in one should not be made at the same place as in the other line, or if transposed on the same pole the sections in one should be twice as long as in the other. If they were transposed alike they would then bear nearly the same relation to each other as if they were not transposed at all. In train dispatching lines the wires are transposed against cross talk and the bulk of the telegraph wires and not against any one telegraph wire.

In case of series arc circuits or power wires special transpositions would have to be cut in. A general rule to cut in transpositions covering disturbances from foreign wires or sudden changes in wires may be stated as follows: Figure as one section the distance between two consecutive changes of any kind and transpose the wires at the middle point of this section. Additional transpositions may be cut in if this leaves the sections too long. Additional transpositions can then be cut in to balance up the rest of the circuit or the next regular transpositions.

Receivers sometimes become demagnetized due to the signaling impulses, when the receiver is off the hook, passing through the receiver in the wrong direction. The direct current impulses will charge the condenser when the receiver is off the hook and this charge will momentarilly pass through the receiver and demagnetize it if it is not connected up properly. Some receivers have a "z" mark on one pole of the receiver and the receiver cord and line wires should be so connected that this will be the negative side of the circuit. An easy test for this is as follows:

Disconnect the receiver and connect the cord terminals to a voltmeter and while the signaling current is on the line short the condenser and note which side of the cord is the negative pole. The receiver cords usually have

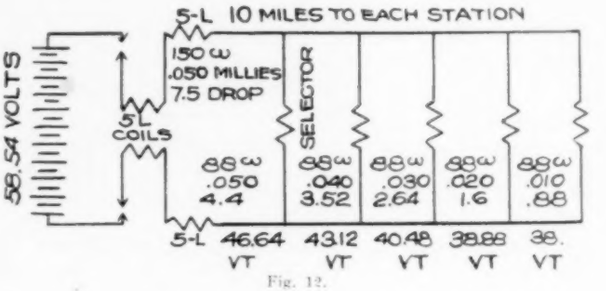


Fig. 12.

a tracer or mark on one of them and this should be used for the negative side. If in testing this happens to be the positive side it can be corrected by reversing the line connections in the sub set, then all future cords may be put on in the same way.

The telephones and apparatus should be frequently inspected with the view of preventing trouble that may arise later due to loose connections, etc. Receivers should be inspected for dents in the diaphragm, foreign matter lodged between the diaphragm and cap or magnet poles, and also for loss of magnetism. The permanent magnets should be strong enough to hold up the diaphragm on its edge.

The transmitters frequently become filled with foreign matter between the diaphragm and face plate, especially if the mouthpiece is gone.

This should be cleaned out, as it will cause poor transmission. A frying noise in the telephone is caused by too much battery or by loose connections in the primary circuit.

All connections should be examined to see that they are not loose and dirty contacts and connections should be cleaned. Lightning arresters should be examined for partial grounds, loose connections, and defective ground wires.

All connections both inside and cable pole should be soldered. This is a very important point in connection with efficient telephone operation.

The condenser in the telephone sets sometimes becomes shorted, causing a failure of the selectors when the

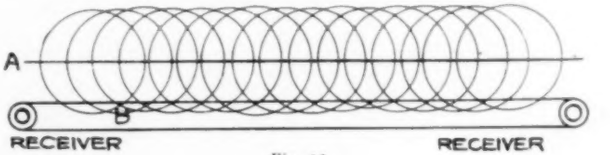


Fig. 13.

receiver is off the hook. This can be determined by having the dispatcher ring the station with the receiver off the hook. If the selector fails to operate try it again with the receiver hung up. If the selector now operates the condenser is shorted at this particular station and should be replaced. A partial short in the condenser may not

cause a selector failure but it will cause a loud interference in the receiver due to the current flowing through it and a defective condenser may be located this way by listening while the dispatcher is calling someone.

A loud cracking in the receiver when the dispatcher is ringing on the line is caused by a partial short on the line.

The telephone line will become noisy if either wire becomes grounded, open, or crossed with another wire.

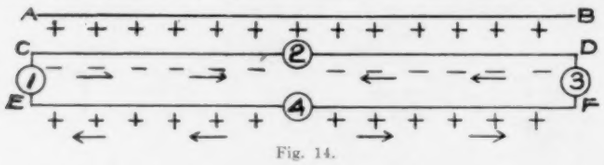


Fig. 14.

The trouble may be located between sections by having the line test switches opened one at a time. If the noise stops when a switch is opened the trouble is beyond that office. If the noise is still in when the switch is opened the trouble is between you and the office. In this way the trouble may be located between two test offices. An open circuit may be caused by a broken wire in the line, a defective cable pair, or a defective switch in a test office. A ground may be on the line or in an arrester in an office. A cross would most likely occur on the line. After locating the section in which the trouble is in it may be located to the station or between stations as follows:

In case of a ground or cross, call a station and have him short his line switch with a knife or car seal and if this quiets the line the trouble is beyond him. If in trying the next station the noise still remains, the trouble is between these two stations. An open can be located in this way. In case of a solid short on the line this same test can be reversed and used in the same manner by having the station put a ground on one side of the line. This can be done by placing a car seal or wire from one line wire to the ground post on the lightning arrester. Grounds may also be located by having the various offices open their office switch and see if this clears the line. If the arrester is grounded the operator can clear same by removing the carbon blocks from the arrester. It sometimes happens that during a storm several offices will become grounded and they will have to be located one at a time.

An open in the line will cause noise in proportion to the distance it is from the end of the line. Thus a line may be open near one end of the line and appear very noisy to the man at that end and comparatively quiet to the man at the other end of the line. An open will cause a failure of selectors beyond the open and sometimes cause a failure to a number of selectors between the dispatcher and the open due to the adjustment of the se-

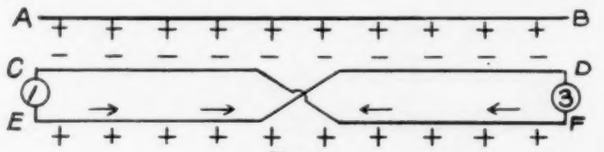


Fig. 15.

lectors and the abnormal current flowing through them. A short will also have the same effect on the selectors so that trouble can not always be located by the stations the dispatcher is able to call.

These listening tests may be applied by the telephone maintainer or operator at any station on the line and it is a good idea to have two parties listening in when these tests are being made as the results can then be compared and locations simplified. Considerable practice is required to locate accurately the trouble between stations with listening tests, due to the slight change caused in the noise when the fault is close to a station under test.

Telephone Equipment for Electric Railways

In a paper on "Overhead Standardization," read by A. Schlessinger at a recent meeting of the Central Electric Railway Association, he stated that there is a difference of opinion regarding the relative advantages of telephones located in booths at sidings and portable telephones on cars with jack boxes on poles at sidings and approximately every mile between sidings. Of course, both plans have their advantages, but when the telephones are located in booths out on the line it is necessary to have one at each siding, including the ones that are not used for scheduled meeting points. Sometimes trains do not use these sidings for several months and the trainmen do not have occasion to use the telephone. Consequently the condition of the instrument is not known until it is needed and then it is quite likely to be out of order, whereas the car telephone is frequently used and its condition is always known. Furthermore, if it should get out of order it can be replaced with another portable set at one of the terminals or at the dispatcher's office without delay to the train.

Where jack boxes are used at each siding there should be two so located that trainmen may communicate with the dispatcher from the car without fouling switch points. Where there is a commercial telephone line in addition to the regular dispatcher's line an additional jack box should be connected thereto at all sidings for use in case of trouble on the dispatcher's line.

Test switches should be installed in all substations and junction points, and occasionally at other stations where employees are on duty. These will enable the dispatcher or linemen to locate quickly the section of the line in trouble.

The dispatcher's telephone switchboard is usually made up with small knife-blade switches, which wear and work loose quickly and cause poor connection and noisy and poor talking lines. The cord and plug-type board is more convenient and offers more combinations and greater flexibility in the operation for the dispatcher, but unless this type is specially designed and built to withstand burn-outs or breakdowns in insulation considerable trouble may be experienced in case telephone wires become crossed with higher voltage wires.

It is therefore necessary to get away from the standard telephone apparatus and to use equipment of more rugged design with increased insulation. This is easily done, but the manufacturers call it special and the price we must pay for it is entirely out of proportion to the price of standard equipment. This seemingly excessive price has a tendency to limit the demand for the equipment most suitable for electric railway service. The demand for the standard apparatus is practically unlimited and it can be built for a lower first cost. But its use results in increased maintenance expense, and this, I believe, strengthens the theory that only through standardization can electric railways secure the material most suitable for their service at a reasonable price.

Observations on Telephone Transmission

By J. L McQuarrie*

SIMULTANEOUS TELEGRAPHY AND TELEPHONY.

FOR a long time extensive use has been made of means permitting the simultaneous use of a line for telephony and telegraphy. If the two wires of a metallic telephone circuit are used for independent grounded telegraph circuits, we say the line is "composited"; but if the two wires of the telephone circuit are used in parallel as a telegraph circuit, we say the line is "simplexed." The compositing of a circuit does not limit the possibilities of also using it as one side of a phantom. The composited or simplexed circuits result in large savings, but whether the former or latter should be used depends upon a number of considerations. It may here be stated, however, that in general the use of simplexed circuits presents fewest complications so that where an adequate supply of telegraph circuits can be obtained by this method it is not usual to resort to composited circuits. This should not be understood as implying that the use of composited circuits involves much complication, since, provided suitably designed equipment has been procured, the operation of composited circuits presents no difficulties. The transmission loss due to the addition of composite apparatus to the two ends of a circuit is just noticeable, being about ten per cent or one mile of standard cable. The loss due to simplexing depends upon the type of simplex employed, whether "bridged retardation coil" or "repeating coil," and in each instance upon the type of apparatus used. In the case of small, cheap repeating coils sometimes employed, the loss may be serious, being perhaps fifty percent or six or seven miles of cable.

In the case of composite apparatus especially, it is important that it should be carefully designed so that the telephonic efficiency will be a maximum and the chances of interference due to noise between the telegraph and telephone made a minimum.

MEASURING TRANSMISSION VALUES.

In the successful practice of any art it is essential that means be provided for measuring the values of its elements, and a standard method of measuring the value of telephone transmission has been developed. In the earliest days of telephone practice it was customary, when comparing two instruments, or when comparing the transmission over two lines, to express the difference in transmission by the statement that one of them was a certain per cent superior or inferior to the other. The objection to recording the results of tests in this way is that no two observers expressed a given difference in transmission efficiency by the same percentage. Each observer had a certain arbitrary standard by which he expressed the differences; thus, for instance, an observer might note a difference which he could just distinguish as 5 per cent, a comparatively important difference by 15 per cent and a very large difference by 50 per cent. Another observer might express a difference which he could just distinguish by 1 per cent, a comparatively important difference by 5 per cent, and a very large difference by 15 per cent or 20 per cent. It therefore became necessary to choose some standard unit so that the results of different observers could be compared, even if one was a telephone engineer in the United States and the other a telephone engineer in a foreign country. The engineers of the American Bell Telephone Company selected as the basis for a standard of transmission a No. 19 B. & S. gauge paper insulated cable, having a capacity of .054 microfarad per mile. The transmission efficiency of a telephone circuit between two standard substations could then be stated to be equivalent to a certain number of miles of standard cable. If this circuit was changed in some small detail, such as, for example, by the insertion of a bridged drop, the changed circuit was then noted to be equivalent to a slightly different length of standard cable. The difference between the two lengths of standard cable corresponding to the line with and without the bridged drop was said to be the transmission loss or gain, due to the insertion of the bridged drop; or, as another illustration, if with one type of transmitter it was possible to talk over a given length of No. 19 gauge cable, while with another transmitter the same volume was obtained over a different length of standard cable the difference between the two lengths was said to measure the inferiority or superiority of one transmitter over the other. As it is not convenient to use actual No. 19 gauge cable circuit, artificial cables were designed in convenient form for transmission testing. It should be here pointed out that in the use of artificial lines, or for that matter in the use of actual No. 19 gauge cable, certain precautions must be taken in order to avoid false results. For instance, the insertion of one mile of No. 19 gauge cable in the middle or at the end of an aerial line does not increase the transmission loss over the circuit by the same amount as does the insertion of a short length of cable, such as one mile in a similar cable circuit. To illustrate: If open wire lines were being compared and they differed slightly, correct results would not be obtained if, in order to make the volume the same, a short length of cable, say one or two miles, were added to the circuit having the better transmission. The length of cable added would not represent the difference in transmission efficiency. One method of measuring the transmission efficiency of the two circuits would be to determine the equivalent of each one in terms of standard cable, then to take the difference between the two noted results as representing the difference in efficiency of the two circuits.

ECONOMICS OF CONSTRUCTION.

To one called upon to furnish telephone facilities the important problem is to determine in detail what construction should be employed in order to obtain the required result at a minimum cost. The difference in price between the very best and inferior instruments is so small that there should be no excuse from a financial point of view for the purchase of inferior transmitting or receiving apparatus. Compared with the cost of the lines, as will be illustrated later, the differences in the price between the very best telephone apparatus

*A paper read before the Railway Superintendents of Telegraph at the convention held in Boston June 26 to 30. Concluded from September.

and the poorest is infinitesimal. The largest economics, therefore, which it is possible for one planning a telephone system to achieve are accomplished by savings in line construction and by the use of such methods of operation as will secure the maximum use of the facilities provided.

In dealing with this phase of the problem it is first necessary to establish a standard of transmission which it is desired to furnish. Preferably, this standard of transmission should be expressed in miles of standard cable, although if it is so desired it can be expressed in terms of an open wire copper circuit of a given loop resistance or weight per conductor per mile. If different classes of lines are to be considered, it may be advisable to have two standards, one for a certain class of service, perhaps the bulk of that which is being considered; the other for a certain special class of service which represents but a small percentage of the total amount. For instance, it might be desirable to fix for certain classes of service a 20 mile standard, while for other classes of service a 30 mile standard might be considered satisfactory.

Having established the standard of transmission, I may point out certain general principles for guidance in determining the most suitable construction. If the circuits are to be wholly of open wire, the problem is comparatively simple. If copper wire is to be used, mechanical strength limits the engineer to the use of wire not below 160 or 175 pounds in weight, although climatic conditions, such as sleet or high winds, must be taken into consideration. Very approximately, where copper is used the length of line over which it is possible to give the desired standard of transmission is inversely proportional to the resistance of the circuit per loop mile. To illustrate, if transmission between two substations of a standard type is satisfactory over a 400 mile line of 210 pound copper wire having a loop resistance per mile of approximately 8 5 ohms, then an equal grade of transmission can be given over a circuit 200 miles in length by using copper wire weighing approximately 105 pounds per mile and having a resistance of approximately 17.0 ohms per loop mile. However, as the latter size of wire under ordinary conditions does not possess satisfactory mechanical strength, it is necessary either to use larger copper wire or to use bi-metallic wire, selecting in this case a size and grade of wire which will provide mechanical strength with a resistance not in excess of that of the 105 pound copper conductor, or 17.0 ohms per loop mile.

Two cautions may well be introduced here: First, that this proposal is only approximate and, since exact transmission efficiency involves the knowledge of an experienced telephone engineer, it is well, where the amount of construction is considerable, to obtain the advice of an expert, because the difference in cost between two sizes of wire may represent a very large sum of money. Second, for iron wire circuits no simple rule applying to different gauges of wire can be given, since their efficiency is not simply related to the weight or resistance, as well as for the reason that in the case of iron wire circuits there is a tendency for the joints to become of high resistance, causing an old iron circuit to have a much lower transmission efficiency than the same circuit when newly installed.

In the case of cables, the transmission efficiency varies inversely as the square root of the product of the loop resistance and the mutual capacity. Diverging for a moment, since in the past there has been some confusion in regard to the capacity of a cable as affecting transmission, it may here be emphasized that it is the mutual capacity between wires of the pair and not the grounded capacity of a wire or conductor which influences the transmission. However, it can be added that for ordinary paper insulated lead covered cables the ratio of the mutual to the grounded capacity is nearly constant, being approximately two-thirds. Hence, if in one case the mutual capacity is known and in the other only the grounded is available, it is possible to compute the mutual capacity in the latter case and then compare the two cables.

To illustrate this rule governing the efficiency of cables, an example or two may be presented. Very approximately the capacity of paper insulated lead covered cables of different gauges may be taken as the same, since it is common practice so to construct them. Assuming No. 19 B. & S. gauge cable as the standard, a No. 16 B. & S. gauge cable which has approximately half as many pairs for the same size of lead sheath and for the same weight of copper, gives only a 40 per cent increase in transmission efficiency over the standard No. 19; or, in other words, 1.4 miles of such No. 16 gauge cable is equivalent to one mile of No. 19 gauge cable. In the same manner, two miles of No. 13 gauge cable gives the same transmission loss as one mile of No. 19 gauge cable of the same capacity; that is, in the case of non-loaded cables, of which I am now speaking exclusively, to double the transmission efficiency it is necessary to multiply the weight of the copper conductor by four, which obviously results in a very large increase in cost.

Regarding the capacity of cables, it may be pointed out that, in order to obtain a change in mutual capacity of, say, from .070 to .054 microfarad per mile, it is necessary to reduce very greatly the number of pairs in a cable having a given sized sheath, the reduction in some cases being almost as great as 50 per cent. While it is not possible to formulate a rule applicable to all cases, it has in general been found to be economical to use cable having a reasonably high capacity, that is, a rather compact cable, and then where necessary to increase the transmission efficiency by increasing the size of the conductor one gauge rather than to attempt to secure the transmission gain by a low capacity. This is especially true when the price of copper is low.

The above directions apply to cases where the transmission circuit is wholly a cable line or wholly an open wire line. If of necessity the circuit must be carried for part of the distance in cable and part of the distance in open wire, the problem is much more complicated, since in order to obtain a standard grade of transmission at a minimum cost it is necessary so to proportion the cost of the cable portion of the circuit and the cost of the open wire portion of the circuit as to produce a minimum cost for the whole line. In a paper of this nature it is hardly possible to present even general rules to cover the methods to be followed in so proportioning costs. I may, however, illustrate what is not good practice by an example: If it is desired to furnish transmission between points 400 miles apart, and if of this distance conditions require the use of a cable for ten miles, the remainder of the distance being open wire, it would obviously be

uneconomical to use a large gauge conductor, such as a 420 pound copper wire, for the open wire portion of the circuit, and for the cable portion of the circuit to use a No. 22 gauge cable. It would probably be more nearly correct proportion to use a 210-pound copper conductor for the aerial portion of the circuit, and a No. 10 gauge conductor for the cable portion of the circuit. The actual details of construction, however, depend upon several factors, such as the number of circuits which it is desired to provide, whether the cable is to be underground or aerial, etc., etc.

It will in most cases be necessary to equip the telephone line not only with apparatus directly concerned with the transmission of speech, such as the transmitter and receiver, but also for the purpose of signaling there will be required apparatus, such as bells, drops, relays or repeating coils, and these devices will have to be considered in calculating the line. A few general statements more or less in the way of caution may be in place with respect to the use of such appliances. First, referring to bridged apparatus, it being assumed that excepting for very special cases series apparatus is not to be employed, it should be pointed out that the effect of bridged apparatus on the transmission does not depend on its direct current resistance, but upon its impedance to currents of telephonic frequencies; that is, it is quite possible that a drop having a resistance of 200 ohms would not cause as great a transmission loss as another drop having a resistance of 500 ohms if the first drop mentioned had a higher impedance to telephonic currents. For a given style of drop, it is true that the higher the resistance the higher the impedance, but in considering transmission values it is not safe to compare drops of different design and construction on the basis of their direct current resistance.

In the case of other apparatus, such as phantom circuit repeating coils, no rule can be given for the transmission efficiency of the coil, since in the design of the repeating coil an attempt has been made to secure adequate ringing efficiency as well as high transmission efficiency. As a general rule, however, the cheaper coils on the market are inefficient from a transmission standpoint. In this connection a word may be said regarding the importance of guarding against transmission losses in the apparatus attached to the circuit. Illustrating by the case of phantom repeating coils, it may be said that the cheapest coil on the market costs perhaps $4, while the most expensive coil on the market costs approximately $15, a difference of $11. For the complete equipment of the phantom circuit the difference in cost of the four coils is therefore but $44. Considering the transmission loss at the two ends of the side circuits, the difference in transmission efficiency between the cheap coils and the high grade coils is perhaps four miles of No. 19 gauge cable. It is not a difficult problem in the case of any circuit to determine the cost of making up this transmission loss by the use of a larger gauge of copper conductor. In most cases it will be found that the cost of making up the loss introduced by the coils will be from 10 to 100 times greater than the saving which results from the use of the cheaper coil. Therefore, in an efficiently designed plant the use of cheap apparatus involving a large transmission loss is not in general found to be economical. This, however, must not be taken to apply to special cases where a satisfactory grade of transmission can be given over circuits with an inefficient type of associated apparatus. Such cases arise where, for the purpose of mechanical strength rather than for the purpose of telephone transmission, it is necessary to use a certain type of construction. In this connection also it may be pointed out that a transmission test on a piece of apparatus such as a drop is not a sufficient indication that the drop would in every case be satisfactory from a transmission point of view. A loss of much less than one mile of standard cable cannot be readily determined even by experts in transmission. Since to make up a loss of a fraction of a mile of cable by increasing the size of the conductor means the expenditure of a large sum of money, the actual amount depending upon the circuit, even losses as small as one-tenth of a mile of cable cannot necessarily be neglected. A safe practice is to secure the best apparatus from reliable sources which can be depended upon to give accurate data regarding the behavior of the apparatus and circuit.

CONDITIONS OF MAINTENANCE.

As the satisfactory quality of telephone transmission depends to a large extent on what is usually termed the maintenance of the telephone lines, it may be of interest to emphasize certain features involved in maintenance. Poor maintenance results in three defective conditions:

1. Decrease in actual telephonic efficiency; that is, the telephone currents themselves are not transmitted with full efficiency.

2. Noise due to leaks to ground or to adjacent lines, which may be either telegraph, power or lighting circuits.

3. Crosstalk or overhearing from adjacent circuits.

Even when the maintenance is not so poor as to cause an actual decrease in telephonic efficiency but merely to cause noise or crosstalk, the net result is a decrease in telephonic efficiency since speech is rendered less distinct. As far as the electrical requirements are concerned, maintenance should care for the following points: In order to prevent a reduction in actual transmission efficiency the maintenance should be of such a character that under no conditions of weather will the insulation between the two sides of the circuit fall below a certain permissible minimum. As a matter of fact, however, in the case of actual non-loaded circuits, the permissible minimum for the insulation is rather low if it is uniformly distributed, and not much trouble in practice is encountered in securing a satisfactory value, especially as it is only in cases where insulators become soiled or where the lines come in contact with foliage that the insulation falls, even under the worst weather conditions, to a seriously low value.

Considering the matter of noise and crosstalk, however, the electrical requirements are that the two conductors should themselves be electrically similar and similarly located electrically with reference to all other wires and the earth. By the two wires being electrically similar it is meant that they should be of the same size and of the same material, and that neither wire should contain high resistance joints. By stating that the wires should be similarly located electrically with reference to other wires and to the earth it is to be presumed that, under the usual conditions, the wires have been balanced by transposi-

tions. If, however, one wire has a large leak to earth at a given point, and the other wire is well insulated at this point, the balance secured by transposition is disturbed and the chances are that the line will become noisy or that there will be crosstalk. For this reason leakage to earth through poor insulation which is not the same for the two wires is very likely to cause noise.

The problem of securing a satisfactory grade of telephone transmission at a minimum cost is not by any means a simple one. However, it is a problem which admits of exact engineering or of as exact an engineering solution as the corresponding problems in power distribution. One called upon to provide telephone transmission facilities as compared with one called upon to provide power transmission facilities, is confronted with two difficulties: First, the problems involved in the case of the telephone are more complex; secondly, the telephone apparatus of different manufacturers is not as yet classified in a standard manner with respect to performance, while power apparatus, such as generators, motors and transformers, is rated in definite units as to efficiency, consumption of energy, output, etc.

Each manufacturer, I presume, is prepared to furnish information about the efficiency of its own apparatus; at least the company with which I am associated is prepared to do so, and this data is in such form that it may be used in calculations to determine the proper relation between transmission efficiency and plant economy.

The knowledge which has been acquired in the past concerning the factors involved in telephone transmission, coupled with the scientific investigations which the engineers of the Bell interests are continually conducting, justifies the feeling that the future promises even greater results in transmission efficiency than have been realized in the past.

Telephone Train Dispatching in Hudson Tunnels

The Pennsylvania Railroad Company has recently ordered fourteen Western Electric selectors for use in its Hudson tunnels. The section equipped is known as the Jersey City-Newark division, and it is nine miles in length. The dispatcher will be located at what is known as the "S. C." tower, and No. 16 B. & S. copper wire will be used. The standard 50-A Western Electric selectors will be installed, and, in addition to this, fourteen special six-line test boards have been ordered. There will also be thirteen ten-line jack boxes, which will be used for blocking purposes.

C. M. & St. P., Extends Telephone Dispatching

The Chicago, Milwaukee & St. Paul, which is already operating approximately 2,000 miles of track by the telephone, has recently ordered of the Western Electric Company seventy-five telephone selectors for use on its Hastings and Dakota division. Three circuits will be installed, the total mileage being about 390 miles. One circuit will run from Montevideo, Minn., to Minneapolis, Minn., with a branch from Benton Junction to Farmington Yards. There will be twenty-eight stations on this circuit and the dispatcher will be located at Montevideo. A second circuit will run from Aberdeen, S. D., where the dispatcher will be located, to Mobridge, S. D., a distance of 98 miles, and will be equipped with twelve stations.

Another circuit will run from Aberdeen, S. D., to Montevideo, Minn., a distance of 120 miles. The dispatcher will be located at Aberdeen and twenty-three stations will be equipped. No. 9 B. & S. copper will be used on all three circuits.

Harriman Roads Adopting Telephone

The seven lines of the Harriman system are replacing the telegraph by the telephone for train dispatching. Simplicity, quickness and economy are the points in favor of the telephone advanced by railroad men. By the telephone the train dispatcher is enabled to handle the rolling stock of his road in one-tenth of the time required by the use of the telegraph.

The Southern Pacific, the Union Pacific, the Oregon Short Line, the Oregon-Washington Railroad and Navigation, the San Pedro, Los Angeles and Salt Lake, the Galveston, Harrisburg and San Antonio, and the Houston and Texas Central are the Harriman lines that are adopting the telephone to dispatch trains.

On the Southern Pacific telephone dispatching is in operation between Salinas and Santa Barbara on the Coast division, on the entire Shasta division, on the Sunset, and the Sunset and Western and McKittrick branches. It will soon be established between Sacramento and Sparks. Railroad officials say it is only a question of time until the telegraph will serve only as an emergency service on the Southern Pacific and other Harriman lines.

"Walsh" Road to Use Telephones

The Chicago, Terre Haute and Southeastern railway has abandoned the telegraph system of train dispatching and adopted the telephone for that work. The work of installing the new line between the Grand Central station at Chicago and the Southern end of the former Chicago and Southeastern at Terre Haute has been completed and tests will be made at once.

The telegraph will not be entirely dispensed with and considerable business will continue to be handled in the old way. Through Danville the C. T. H. and S. E. or Walsh road as it is still called (and probably always will be on account of its short sound and the old associations) now has three systems of communication. The first is the telegraph; then came the telegraphone, by which talking can be done over train dispatching wires without disturbing the operator or even allowing him to know that communication is passing over the telegraph wires. Then comes the new telephone system, which is a hybrid affair containing the best parts of a half dozen earlier attempts at train telephoning.

Atlantic Coast Line Extends Telephones

The Atlantic Coast Line has recently placed an order with the Western Electric Company for ninety station telephone train dispatching equipments, which will be used to equip 235 miles of track. A train, a message and a block circuit will be installed between Savannah, Ga., and Jacksonville, Fla., with a branch from Jesup, Ga., to Waycross, Ga., and from there back to Folkstone, Ga., where it again meets the main line. The train dispatcher will be located at Savannah.

Current Supply for Selective Systems

By W. E. Harkness*

SELECTIVE calling systems now in general use on railway telephone dispatching and message circuits may be divided into two general classes, according to the method of sending out the selecting current which operates the selectors connected to the circuit. These two divisions are:

A. Combinations of current impulses.

B. A series of consecutive current impulses.

The first or combination system consists of sending over the line combinations of current impulses ranging from two to five groups, these groups being separated by predetermined time intervals. The groups of current impulses may consist of from three to ten impulses separated by intervals equal in length to the impulses themselves. The time interval between groups will then be of relatively greater length than that between the impulses forming a group.

For mechanical reasons it is necessary, in some combination call selectors, to precede or follow the calling impulses with a group of clearing-out impulses. This group contains one more impulse than the highest group in the calling combination, in order to restore all the selector mechanisms to normal.

The second general division, employing a series of consecutive current impulses to close the signal circuit at the desired station, is limited in the total number of selections, owing to the large number of current impulses required to meet service conditions. In other words, while station No. 5 is selected with five impulses, station No. 20 will require twenty impulses, and station No. 45 a corresponding number of impulses.

In the various types of selectors in use, two sources of current supply are employed to operate the bell or signal at the way station:

First: By providing one or more cells of battery at th weay station to operate a low resistance bell, and

Second: By using current transmitted over the line wires from the same main battery which provides current for operating the selectors, to operate a high resistance bell at the desired way station.

When the main line bell is employed, the two systems of selection consume practically the same amount of current for operating the bell during the ringing period. The current consumption to operate the two types of selectors may differ slightly, depending upon the type of combination selector employed.

FACTORS GOVERNING CURRENT CONSUMPTION.

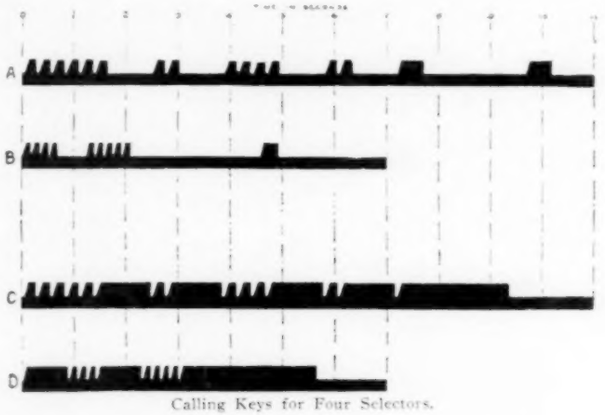
The amount of current in amperes required to operate a selective system depends upon the design and construction of the selectors and the margin of operation determined upon. In practice the normal operating current of the principal selectors used ranges from eight to ten milliamperes, the latter being that customarily used in the preliminary calculations to determine the total voltage of the main battery. The current values mentioned are, however, far in excess of the minimum current at which the selectors will operate; in fact, they are from two to two and a half times the minimum operating current.

In addition to the minimum operating current at which a selector will function, the maximum current at which the selector will continue to operate should be borne in mind to insure satisfactory operation of the minimum number of selectors remaining on a line which may be open near the dispatcher's office. The maximum operating current should be at least three times the normal operating current.

In addition to the amount of current in milliamperes, the length of time this current is applied to the line during a call must be considered, as well as the number of calls. The length of time current is on the line depends upon the type of selector used.

The illustration shows graphically the difference in the calling keys required in four types of selectors. These are drawn to scale.

A represents that of a four-figure, eleven seconds local bell selector key. The combination is 2421. The



Calling Keys for Four Selectors.

six impulses in the first two seconds are clearing-out impulses. The two wide teeth at the right show the ringing interval.

B represents that of a two-figure, seven-seconds local bell selector key, the combination being 45.

C represents that of a four-figure, eleven-seconds main line bell selector key, with the combination 2421.

D represents that of a two-figure, seven-seconds main line bell selector key, combination 45.

The combinations shown contain the average number of impulses per call and, as shown, are the same for the local and main line bells of the two types.

When the foregoing are reduced to figures we have the following times during which the main battery is in service during one call:

	Type	Battery closed
A—Local battery bell	4 fig. 11 sec.	2.75 sec.
B—Local battery bell	2 fig. 7 sec.	1.05 sec.
C—Main line bell	4 fig. 11 sec.	7.2875 sec.
D—Main line bell	2 fig. 7 sec.	4.725 sec.

With the foregoing as a basis and various numbers of calls per day, charts have been prepared showing the total ampere-seconds required for the four

*Abstract of paper read at the Boston convention of the Association of Railway Telegraph Superintendents.

types mentioned, at different rates of calling for circuits of from 10 to 50 stations. From the information thus shown, the proper ampere-hour capacity of the battery required for any circuit employing the types of selectors described may be determined.

STORAGE BATTERIES.

Storage cells are rated by their ampere-hour capacity, which is governed by the area of the plates in the cells and somewhat by the rate of discharge. The number or size of the plates used may be varied to obtain cells of different ampere-hour capacity. As selective calling systems require a comparatively low capacity and a slow rate of discharge, small cells may readily be used.

In order to provide for emergencies such as interruptions to the power circuit or trouble with the charging apparatus, it is desirable to allow an excess ampere-hour capacity. Provision for at least three days' excess ampere-hour capacity should be made; double this provision is advisable.

In assembling the storage cells into a main battery, various types of construction are employed. The form employing "couples" consisting of a negative and a positive plate with their connecting lugs burned together is the simplest and cheapest and is considered the best for this class of service.

One of the main objections urged against the storage battery has been the maintenance, an objection which seems to be due mainly to the assumption that such batteries cannot be maintained without skilled labor. This objection is believed to be less serious than has been anticipated, for the reason that the average telephone inspector or repair man can, after a little study of the instructions furnished by the manufacturers, care for a storage battery in a satisfactory manner.

CHARGING APPARATUS.

Several methods of charging the storage batteries may be employed, the choice of method to be used depending upon local conditions. They are as follows:

1—Charging direct from direct current lighting circuits, the proper amount of charging current being regulated by means of a rheostat or bank of lamps. This method may be employed only where the voltage of the storage battery is lower than that of the lighting circuit. As the usual selective circuit requires a battery of over 100 volts, this method is seldom used. This method cannot be adopted when alternating current lighting circuits are used.

2—Charging by means of a small direct current generator driven by a direct or alternating current motor operated from the commercial lighting circuits. This is the most flexible and satisfactory arrangement, as the generator may be connected directly to the line in case it is necessary for any reason to cut the battery out.

3—Charging by means of mercury arc or other forms of alternating current rectifiers. This, like scheme 1, is, to a certain extent, limited to charging batteries of a voltage lower than that of the circuit supplying current. The maximum voltage at the battery is 115 volts when the rectifier is connected to a 220-volt alternating-current circuit, and 175 volts when connected to a 330-volt alternating-current circuit. This will, in some cases, necessitate splitting the battery into sections for charging, or providing a duplicate set of batteries to be used while the regular set is being charged.

ALTERNATING CURRENT RECTIFIERS.

The type of rectifier which is best known is the mercury arc type. There are, however, some other types which have a lower first cost, but are not capable of transmitting as large currents as the mercury arc type, nor are they as efficient. They have, however, sufficient current capacity for the service under consideration. The principal advantage of the rectifier over the motor generator set is that it has no moving parts and the set may be operated by inexperienced employes. Its disadvantages are the renewal and breakage of the glass tube in the mercury arc type, and the handling and cooling of the liquid, together with the renewal of the electrodes in the liquid types.

The relative costs of the several suitable types are as follows:

Basis of Annual Charge—Depreciation.

Items	Life.	Salvage.	Depreciation.
Storage batteries	5 years	0	20%
Charging plant	8 years	25%	9.375%
Interest on investment			6%

Maintenance Charge:

Labor—It is estimated that the batteries and charging equipment will require the services of one man one day a week. The rate of pay of such a man being estimated at $3.00 per day equals, per year $156.00

Material—Acid and water for batteries per cell per year ..... .05

Oils, waste, etc., for motor generators, per set per year 3.00

Operating Expense: The power used to operate the motor-generator sets or for charging the batteries direct is based on a rate of 10 cents per kw-hour on the primary of the charging set. The efficiency of transformation is estimated at 70 per cent. which brings the cost of power at the battery terminals to approximately 14.3 cents per kw-hour.

Owing to the possibility of the storage battery receiving less attention in this service than in regular telephone exchange service, and on account of its low rate of discharge, its efficiency in selective calling service is estimated at 50 per cent of its normal rating. On this basis, the current delivered to the line will cost approximately 28.6 cents per kw-hour, exclusive of the fixed charges.

FIRST COST OF CHARGING EQUIPMENT.

(1) Power panel for charging direct from power circuit. Panel containing low voltage cut-out rheostat, switch and fuses.

Estimated cost		$12.00
Annual charge:	Rate.	
Depreciation	9.375%	$1.125
Interest	6%	.72
Total		$1.845

(2) Motor-Generator Sets.

	500 to 600 watts.	250 to 300 watts.
Type of motor, 2200 volt direct current	$155.00	$120.00
Single phase alternating current	165.00	135.00
Two phase alternating current	130.00	115.00

(3) Power panels, consisting of slate panel containing switches, fuses, rheostat, starting box and ammeter and voltmeter, $95.00.

ANNUAL CHARGES.

A typical equipment will be considered. The circuit is 150 miles long, constructed with No. 9 B. & S. gauge hard drawn copper. There are thirty four-figure battery bell selectors used, and the dispatcher

is located at the end of the circuit. The number of calls per day is 300.

The main battery in this case will have a voltage of 280. The number of storage cells will be 280 ÷ 2, or 140.

First cost of 140 cells at $.50 each	$ 70.00
Annual Charges:	
Depreciation at 20%	14.00
Interest at 6%	4.20
Maintenance 52 days's work at $3.00 per day	156.00
Acid and water per year at $0.5 per cell	7.00
Total annual charges	$181.20

CHARGING CURRENT.

On the basis of charging four hours per week at a 1-ampere rate we have 208 ampere-hours per year, or 58.24 kw-hours, which at 28.6 cents per kw-hour equals $16.65.

The charging equipment in this case could be of 200-watt capacity, when the annual charge for this part of the plant would average $36.

The total annual expense would therefore stand as follows:

Charging equipment	$ 36.00
Batteries	181.20
Current	16.65
Total per year for storage battery equipment	$233.85

By using the charging panel and charging direct from the power circuit, this amount could be reduced to about $190.

In comparison with this we have dry cells which would cost as follows:

A 280-volt battery consisting of 215 cells at 15.5 cents per cell, or	$43.40

It is estimated that these cells will have a capacity of 15 ampere hours, or 54,000 ampere seconds. At this capacity they would last approximately eight months on this circuit before they would have to be renewed. The inspecting and testing of these cells during their life would require approximately one day a month, or a total of twelve days per year at $3 per day, or $36. It would also require at least two days to prepare and set up the new cells every eight months, which at the same rate of pay is equivalent to $4 per year.

The total annual expense for the dry battery installation would then be as follows:

215 cells of dry battery every eight months at 15.5 cents	$57.87
Labor, maintaining	36.00
Labor, renewing	4.00
Total, per year for dry battery equipment	$97.87

On the foregoing basis the dry cells would be the more economical, as at least four renewals of the dry batteries could be made per year before the expense would be equal to the annual expense of operating a storage battery equipment.

The preceding figures will be materially changed if we consider the same circuit using four-figure main line bell selectors. The total ampere-seconds required per day will be found in this case to be 671.4 in place of 247.5, as in the corresponding local battery bell equipment. On this basis dry cells of the capacity previously mentioned, i. e., 54,000 ampere-seconds, would last about ninety days, or four renewals per year would be required. The total annual expense for dry cells in this case would be $225.60.

The storage battery equipment would be identical, the only difference in expense being that of current, which would probably be increased. Assuming this item to be doubled, the total annual expense for storage batteries would be $246.30.

If, as before assumed, the charging panel is used in place of the motor-generator set, this amount will be reduced to approximately $212.

On this basis it is believed that, although the annual expense for storage battery and motor-generator equipment is slightly above that of the dry cells, the figures are close enough to warrant the use of the storage cells, on account of the more reliable service furnished and the reserve capacity possessed by the storage cells.

Michigan Central Telephones

One of the latest railroads to install Western Electric equipment throughout for telephone train dispatching purposes is the Michigan Central. This road has recently put into service a 112-mile circuit from Detroit to St. Thomas, and at the last report it was operating most satisfactorily. Upon this line are located 22 way-stations equipped with the W. E. No. 102-A selector sets and No. 1020 transmitter arms.

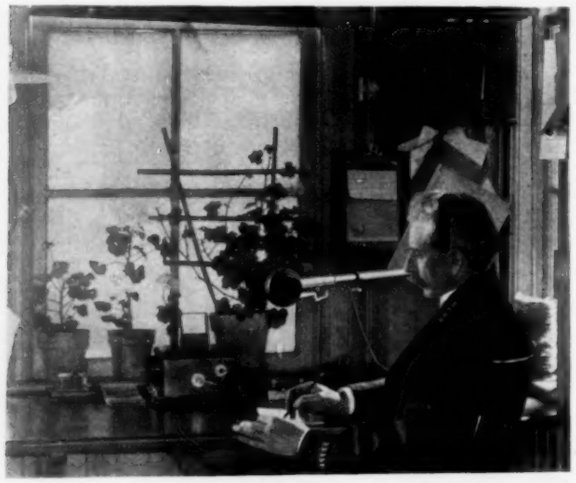
Dispatcher's Office on the Michigan Central.

The dispatcher for this circuit is located at St. Thomas. The Michigan Central is using a special telephone set designed in accordance with their ideas, which contains the desk set box, hand generator and transmitter switch button in one set.

The wreck trains on the division are equipped with No. 1331-E portable telephone sets, enabling the train to be connected to the telephone circuit at any point on the line by means of a standard fishing pole. These portable telephone sets have formed one of the most notable advantages of the telephone in railroad service. The economies which it introduces have been demonstrated in many cases. Delays in traffic are prevented, as well as destruction of property, and even loss of life, by means of their use. They permit railroad officials, when out on the road, to keep in constant touch with their offices if their private cars are so equipped. For keeping engineers and operating officials in constant touch with the progress of construction work, thus economizing time and facilitating the movements of trains, they are invaluable

The Michigan Central is also installing ten siding sets along this division, which consist of the No. 1317-W telephone set of the Western Electric Company. These are mounted in siding boxes along the right-of-way, and enable train crews to keep in constant touch with the dispatcher. These siding sets permit traffic to be handled with much greater flexibility than with the telegraph, and eliminate to a great extent delays, due to holding trains at sidings longer than is necessary.

The circuit in question is paralleled for about 30 miles of its length by a high tension power circuit, and at the outset some little trouble was experienced in removing the noise, due to the induction of this circuit. This, however, was overcome by the use of



Michigan Central Way Station.

frequent transpositions, and the circuit at the present time is not rendered noisy from this cause.

The selector sets used in this equipment are of the most modern and rapid type, and are giving satisfaction on 26 railroads throughout the United States today. This is the selector which was operated over a million times (the equivalent of 29 years of service) without failure. At the end of this time, the selector still met its operating requirements, which all selectors have to pass before being delivered. This is really a remarkable record and from the service which these selectors have been giving among the railroads, it is borne out as being a test which any selector of this type could meet.

This equipment on the Michigan Central makes a total of 425 miles so equipped with W. E. equipment for dispatching purposes covering a total of four divisions. In addition, the Michigan Central has a number of other circuits which are equipped with W. E telephone equipment.

Large Private Telephone Exchange

The Philadelphia and Reading Coal and Iron Company claims to have the largest private telephone exchange in the world. The company operates over 600 telephones. These telephones are to be found in the mines as well as on the surface. Every official has a telephone in both his office and his residence and any time he can talk from either place right down into the mines.

Mine Telephones Becoming Universal

The use of mine telephones is extending very rapidly, and they will eventually supplant all other methods of signaling. In deep shafts communications by means of telephones is almost imperative; in fact, mining legislation in some states compels their use, says Rollin W. Hutchinson, Jr., in the *Engineering Magazine* for September.

A modern mine-telephone system enables the mine superintendent to get in communication with the foreman or any operative in a few seconds or minutes, instead of having to dispatch a messenger to the place of operations, which might require many minutes or an hour or two before results could be obtained; second, in case of danger, such as explosions or floods, a telephone system enables the foreman or operative to communicate with the surface at once and possibly save lives and property; third, in case of injury to an employe, word can be telephoned outside and by the time the employe is brought to the surface a physician can be in waiting.

If an accident happens to the working machinery and the services of a force of workmen are required to repair the damage, no time need to be lost in dispatching a messenger to the superintendent's office. No other means gives the superintendent so complete control over all parts of the mine as does a telephone system. If desired, arrangements can be made (as is often done on rural telephone lines built by farmers) to have a signal which will ring the bell of every telephone on the line; thus an order can be given to every foreman in the quickest possible manner.

Uses Telephone Battery for Motor Boat

Many novel uses of the telephone have been developed in the case of emergencies, as shown by the experience of a New England telephone and telegraph pay station attendant. An accident having occurred in the vicinity of the pay station in which the immediate services of a physician were demanded, a message was sent to the pay station, asking the attendant to telephone for the nearest doctor, who should be conveyed across the river in a motor boat, the distance that way being shorter than by land. The message was delivered without delay, but the motor boat failed to work for lack of batteries, when it occurred to the attendant to use the telephone batteries. This was done, the doctor was brought to the relief of the injured one and the batteries were again restored to their original use. The physician afterwards told the attendant that his ready wit, in all probability, saved the life of the injured party.

Western Road Builds New Line

E. A. Klippel of Portland, superintendent of telegraph for the Oregon-Washington Railroad & Navigation Company, recently announced in Tacoma that wires will be at once placed on the poles of that company now in place, for the company's new telephone service between Portland, Tacoma and Seattle.

The distance to be wired is approximately 150 miles and as soon as the service is in operation all of the officers will have direct telephone service for their own use between the three cities, doing away with the delay now caused by using the regular public long distance lines.

Of Interest to the Trade

By A. L. Haase

A Pole Preserving Machine

It has been proven by close observation that almost without exception poles decay at the ground line, this being due to the fact that long exposure to both air and moisture forms a breeding place for insects which prey upon the wood cells. This being the case it is only natural to suppose that this portion of the pole needs protection. After several years of investigation and experimental work, in their efforts to solve the problem of providing a simple and inexpensive method of supplying such protection, George P. Benton and I. B. Eberhardt, experienced cedar-pole men, evolved the B. & E. pole-preserving machine, which is manufactured by the B. & E. Pole-Preserving Machine Company, Fisher building, Chicago.

A demonstration of this machine was recently given in the pole yard of one of the largest public utility corporations of Chicago. Among those present were about a dozen representatives from the United States Forest Service; also, from several electric utility companies of Chicago and other cities. Three thirty-five-foot poles, cut last winter, were treated seven, ten and fifteen minutes respectively, with heated creosote oil injected by an air pressure of about five pounds per square inch into a three-foot band corresponding to the ground belt of the pole. The ten-minute treatment showed an initial penetration of three-sixteenths inch which extended to a depth of over one-half inch within a few days. In this case the pole absorbed a full gallon of oil in the three-foot band subjected to the treatment.

The accompanying illustrations, from photographs taken during the test, give a fair idea of the machine,

The B. & E. Pole-Preserving Machine.

which is about nineteen feet long and six feet wide, mounted on iron wheels so that it may be hauled about by a team of horses from place to place. It consists mainly of a steam boiler, an air compressor and storage tank, a closed oil tank containing steam coils for heating the oil, an air-tight canvas band three feet wide which encases the portion of the pole to be treated, and the necessary appliances for adjusting and holding same.

The operation of the machine is quite simple. The pole is rolled onto the inclined skids which are placed on each side of the machine, the two segment rings, known as track rings, are closed about the pole by turning a hand wheel, the spool carrying the canvas

The Machine in Operation.

band is then revolved about by an opposite movement of the hand wheel and a clamping bar is wedged against the band so that the latter forms a closed bag or cylinder around the pole. Air pressure is applied to the edges of the band to tighten it and the compressed air is allowed to enter above the oil in the tank, forcing the heated oil through a pipe connection into the bag and entirely around the pole for any desired length of time. Any oil oozing out of the bag drops into a basin on top of the tank, into which it is drained later by opening a drip valve, and thus no oil is wasted. By reversing the operation the pole is released and rolled off the other side of the machine.

Any kind of coal tar may be used. The capacity of the machine is about fifty poles per day and the cost of treating each pole is only a fraction of a dollar for a seven-inch-top thirty-five-foot pole. The process and the machine for carrying it on are fully protected by patents.

15,000 Feet of Cable in Two Days

In making 15,000 feet of 100-pair lead-covered cable in two days the Western Electric Company claims a new record. The hurricane which swept over Charleston, South Carolina, last month left that city isolated from the rest of the world, as far as communication was concerned. The Southern Bell Telephone Company made such heroic efforts to put its plant in operation again that service was resumed in a remarkably short time. More lead-covered cable was needed, however, and the telephone company called up the Atlanta office of the Western Electric Company and placed an emergency order for 15,000 feet, or nearly

three miles, of 100-pair cable. The Atlanta house immediately wired the company's cable plant at Hawthorne. Two days later this 15,000 feet of cable was on its way. In two days nearly three miles of 100-pair cable had been manufactured, placed on huge reels and shipped.

Some idea of the magnitude of this achievement may be had from the fact that to make this cable nearly 12,000 pounds of copper conductor, over 40,000 pounds of lead and over 1,300 pounds of tin were used.

It is interesting to know that the Western Electric Company uses yearly over 100,000,000 pounds of lead, 3,000,000 pounds of tin, 20,000,000 pounds of copper conductor and 4,000,000 pounds of insulating paper in the manufacture of telephone cable.

A Guy Clamp Without Bolts

For years users of guy strand have had to use guy clamps that have been dependent upon the compression of two or more bolts to hold the enormous strains that are put upon the guy strand.

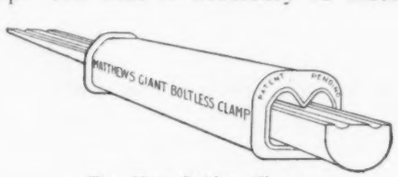
There has been a crying need for a clamp that would positively hold the strains put upon it; that would get away from the time consuming features of bolts and trouble caused by their weakness; that

The Matthews Boltless Clamp in Use.

would eliminate the possibility of the guy strand jumping out when the clamp is drawn up to the pole due to the spread caused by the angle. All of these features have been considered in the design of Matthews boltless guy clamps, the invention of Claude L. Matthews of the well known firm of W. N. Matthews & Brother, St. Louis, Mo.

Matthews boltless guy clamp is made in two sizes, to be known as the "Giant" and "Baby" boltless guy clamps. The Giant boltless guy clamp is designed for very heavy strains, and will fit guy strand or messenger from 5/16 inch to 7/16 inch inclusive. The Baby boltless guy clamp is for lighter strains, and will fit guy strand or messenger from ¼ inch to 5/16 inch inclusive.

Matthews Giant boltless clamp will take the place of two or even three 3-bolt clamps or clips. It cannot slip. All that is necessary to install one of



The Giant Boltless Clamp.

these clamps is to slip the sleeve over the end of the strand before putting it around the pole or anchor, and then put the end of the wire through again after taking the wrap around the pole or the loop through the anchor eye and then drive the wedge in toward the pole or the anchor. If it is desired to take the slack out of the line by means of the clamp this can be easily and quickly done by first striking the wedge a light blow with the hammer and then the sleeve, then the wedge, then the sleeve, until all of the slack is out. Then give the wedge half a dozen good hard blows with a hammer, and then the strand will break before the clamp will slip.

The Matthews' Baby boltless clamp is exactly the same as the Giant, except that it is smaller. It is designed principally for trolley span wires, and all

The Baby Boltless Clamp.

guying where ¼ inch and 5/16 inch strand is used. Its low cost makes it a great money saver. The manufacturers offer to send a free sample of these clamps to anyone upon receipt of fifteen cents for the Giant and ten cents for the Baby.

Baird Pay Stations for Panama

The Baird Electric Company has received an order from the Isthmian Telephone Company, Colon, Panama, for three hundred of its pay stations fitted with electro-magnetic gongs.

By means of the electro-magnetic gongs the pay station signals are transmitted over local battery or common battery lines entirely independent of the talking transmitter. This is a great convenience as the machine can be mounted on a shelf in a booth or against the wall entirely independent of the telephone set excepting a wire connection from the line binding posts.

The signals are loud, clear and unmistakeable as the side tones of the transmitter are eliminated. Should a patron by mistake hang his receiver on the hook while making a multiple coin deposit the operator receives the signals equally well.

The machines for the Isthmian Telephone Company will be fitted with numerical signals, being one stroke on a cathedral gong for 5 cents, two strokes for 10 cents, and three strokes for 25 cents. All the operator has to do is to count the strokes. The Panamaian coins contain about twice the amount of silver used in the United States coins and special slots and channels are therefore being made for their pay stations.

Central Battery vs. Local Battery

"Common Battery vs. Local Battery Operation for the Small Exchange," is the title of the new bulletin, No. 1,017, which has just been issued by the Western Electric Company. This is one of the most interesting and instructive bulletins ever put out by the company. It compares central and local battery equipment from a service and cost standpoint. It gives the local conditions to be considered in determining the type of system, and under this head takes up the following subjects: Character of service, estimated growth of town, outside construction, condition of old equipment, the switchboard and the telephones. It shows how the change may be financed, and the possibilities of increased service from central battery operation, due to better service and decreased

maintenance expense. It also describes the use of the convertible switchboard—a board designed for just this service.

In short, this bulletin gives the things to be considered when deciding whether an exchange having from 50 to 500 lines should be operated on local battery or central battery.

Inter-Phone Set for Private Line Service

The Western Electric Company recently placed on the market a new line of inter-phones which will fill a long-felt want in residences, factories, schools and mercantile establishments where intercommunication between stations is not so frequent as to require separate lines.

These sets are arranged for selective ringing, common talking service; that is, any station may call any other station without interfering with any of the others. These sets are designed for use where conversation between two parties at one time is all that is required. They will give just as satisfactory service as the individual-line type gives on large 24-line

No. 1327-L. Eight-Button Inter-Phone Set.

systems, where often two or more conversations are necessary at the same time. They are made in capacities of four and eight buttons, which will accommodate five and eight parties, respectively.

The figure shows the 8-button set, known as the No. 1327-L. This is a non-flush wall set, but a desk type is also furnished when desired. The standard finish for the 1327-L type sets is oak, but other wood finishes can be supplied to order. The instrument, though compact, is not crowded, and the apparatus is arranged so as to make installation easy, as only one set of batteries is required for the whole system. The instruments are so simple in construction that there is little chance of their getting out of order, and the maintenance expense of the system is practically negligible. This system is recommended where a simple yet reliable means of communication is required at a low cost.

A project for establishing a telephone service in the town of Constitucion, Chile, has been approved.

New Form of Concrete Pole

A new type of concrete telephone pole has been erected in Springfield, Ill. The inventor of the new device is Charles V. Aschauser, local architect, and the first pole was erected by Charles Aschauser, Sr., father of the patentee.

Thirty feet high with twenty-five feet protruding above the ground, the pole is attracting considerable attention from railroad and telephone people.

It is of odd construction, but its oddity in this regard is considered one of the strongest features, showing its adaptation for the purposes intended. The design is of a cross-barred pattern and this shape is followed from the top down to within a foot of the base, which is solid.

On four sides of the center shaft and in the center of each transverse section of the pole is run a half inch rod of twisted iron. Circling these rods and extending around the inner part of the pole are coils of wire, giving the pole increased strength and at the same time permitting a certain degree of flexibility.

Between the corners of the transverse sides are iron grips, located twenty inches apart, and which simplify the task of ascending the pole in stringing wires or making repairs.

The base of the pole, which is ten inches in diameter, tapering off to seven inches at the extreme top, is solid for twelve inches. At the top, poles are left for the placing of cross arms to hold the wires.

According to Mr. Aschauer, a pole similar to the one he has just completed can be built for a little over $5 and they will last a life time. But three sacks of cement were required, the balance of the material being of sand and fine gravel.

Several tests were made to prove the strength of the pole and all were successful.

Company Calls Doctors in Battle Creek

It has proven to be the case that when a person is injured a great deal of time is lost in trying to get help. The person who is doing the aiding is excited and it generally takes them about twice as long to do anything as it ordinarily would. At last a remedy has been found for this through the Bell Telephone Company, at Battle Creek, Mich.

Whenever there is a serious accident, if the person does not know whom to call he can tell central and she will give the message to the chief operator, who will do the calling. All the caller need do is talk distinctly, telling the operator that there has been an accident, to send a doctor, and tell where to send him. This is often forgotten by the callers and in their excitement they hang up before it is ascertained where the call comes from.

If the person calling wishes to have a certain doctor the chief operator will endeavor to locate him, and if impossible will send someone else.

Only two Moroccan towns have telephone service—Tangier and Casablanca. The Casablanca system is newer and more efficient, but the Moorish government, following its action in regard to the wireless-telegraph system and other public utilities, has proposed taking over both systems. Should this be done it is possible that a monopoly for telephones may later be granted.

Wisconsin Commission News

The Wisconsin commission has handed down a decision in response to a petition presented by citizens of Platteville in which they allege discrimination by the Platteville, Rewey and Ellenboro Telephone Company, and one by the company requesting an increase of rates. It was shown that the company discriminated between stockholders and non-stockholders in the matter of rates and installation charges and justified its action by saying the exchange was a private enterprise conducted for the mutual benefit of its stockholders. The commission denounced this practice as illegal and ordered it stopped. The reason given by the company for increase of rates was that it was considered necessary to install a complete metallic return because of interference by electric power circuits. The company was authorized to install a graduated rate schedule ranging from $12 per year for party-residence service to $21 per year for single-line business service upon evidence that a complete metallic circuit has been installed. The company asked for increase in charges from $1 per month, the present rate to non-stockholders, to a graduated scale ranging from $1 per month for party-residence service to $2 for single-line business service.

Toledo & Ohio Central Equips Main Division

The Toledo & Ohio Central, which about a month ago adopted the telephone for dispatching trains on its Eastern division, has recently placed another order with the Western Electric Company for thirty-one telephone selectors for use on its Western division.

This new circuit will extend from Columbus, where the dispatcher will be located, through to the Union station at Toledo, a distance of 132 miles. When both circuits are completed the Toledo & Ohio Central will be operating 280 miles of track by the telephone.

Standard Earth Auger Catalogue

The Standard Earth Auger Company, 1128 Newport avenue, Chicago, has just received from the press and is distributing a handsome booklet in colors showing how "Standard" augers are made and explaining a competitive test made against other augers by a salesman of the company.

The little brochure is very interesting and besides illustrating the method of manufacture of this popular hole digger gives net and list prices on both complete augers and parts. A copy will be mailed to any interested telephone company that drops a postal card.

Telephone in Cook Car

Sever Swenson, a prominent farmer near Grand Forks, South Dakota, who is threshing northwest of Kelly's, has instituted the latest thing in the way of up-to-date service. Mr. Swenson has a telephone in his cook car. The instrument and wires are carried along, the car plcaed alongside the telephone line and the instrument connected. In this way the employees have connection with the city and the telephone is proving a saver of both time and money.

Fire Alarm and Police Wires

"Copper Clad Steel Wire for Municipal Fire-Alarm and Police Signaling Systems," is the title of a report on an investigation conducted by Consulting Engineer Frank F. Fowle, for the Duplex Metals Company. The report makes a 16-page booklet, of interest to all users of wire. Copies will be furnished by the Duplex Metals Company.

A handsome colored postcard, issued by the Chase Motor Truck Company, shows a long row of those vehicles all bearing the name of one concern. It bears the legend "The car that sells in dozen lots."

Brevities of the Business

PERSONAL NOTES.

Charles S. Redding, of the Leeds and Northrup Company, Philadelphia, visited Telephone Engineer last week. He reports business fairly good for this time of the year.

F. L. Gilman, general manager of the Missouri and Kansas Telephone Company, Kansas City, Mo., has been appointed honorary vice-president of the American Society of Mechanical Engineers to represent that society at the Conservation Congress.

William E. Jackson, Chicago, has been appointed by the American Institute of Electrical Engineers as a delegate to the Conservation Congress.

Otto Kienitz, employed in the local office of the Wisconsin Telephone Company at Neenah, has been promoted to the position of manager of the company at Algoma, succeeding F. D. Candlish, who goes to Oconto as local manager of the company in that place.

William Sherrin, wire chief of the Wisconsin Telephone Company at Neenah, has been appointed manager of the New London exchange of the company.

Gus Klotz has been appointed manager of the Independent Telephone Company, Abilene, Texas, to succeed Benjamin Shank, who has resigned to accept a position with the Dallas Automatic Telephone Company.

W. R. James has been appointed general commercial manager of the Home Telephone Company of Detroit, Mich. Mr. James is an experienced telephone man, having been connected with some of the most important telephone companies in the country. For the past two years he has had charge of the sales and soliciting forces of the company for six years previous to that he was division contract agent of the New York and Pennsylvania Telephone and Telegraph Company, with headquarters at Erie, Pa.

J. S. Oliver has been appointed manager of the Southwestern Telephone and Telegraph Company, Calvert, Texas, to succeed John Fulwiler, resigned.

W. B. Matheson, Phoenix, Ariz., has succeeded Frank T. Alkire as secretary of the Overland Telephone and Telegraph Company.

R. L. Ahara has been appointed manager of the Hamilton County Telephone Company, Aurora, Neb.

L. E. Eschbacher, formerly vice-director of the International Bureau of Telegraphs, Basel, Switzerland, recently died at the age of seventy-nine. Mr. Eschbacher spent many years in the telegraph service in France and Algeria and held several important positions under the French government. In 1885 he was appointed secretary of the International Telegraph Bureau at Berne.

J. M. Overshiner, father of E. B. and A. V. Overshiner, of the Swedish-American Telephone Company, died at his home in Chicago September 4 at the age of 70. He was born near Charleston, W. Va., April, 1841. During the Civil War he enlisted with the Seventy-fifth Indiana regiment as wagon maker and accompanied Sherman on his march to the sea in that capacity. After the war Mr. Overshiner settled in Elwood, Ind., where he first became interested in the telephone business in 1893, at which time he purchased the telephone system then

being installed in that place and operated the same for a number of years. He is also the inventor of a number of telephone appliances. He is survived by his wife and the two sons above mentioned. His remains were taken to Elwood for interment and as a mark of respect the business of the city ceased while the last rites were being performed for its former resident.

William C. Maas, division commercial superintendent of Arkansas, of the Southwestern Telegraph and Telephone Company, with headquarters at Little Rock, will be commercial superintendent of the Northeast Texas division, Dallas, Tex., succeeding M. J. Stimson, who will be division superintendent of the state of Arkansas, with headquarters at Little Rock.

H. D. McVey, Bisbee, Ariz., has been appointed district manager of the Bisbee district of the Mountain States Telephone and Telegraph Company, which comprised Douglas, Tombstone, Benson and Bisbee.

W. D. Springer, formerly chief clerk in the general contract agent's office of the Central Union Telephone Company, Indianapolis, Ind., has ben appointed manager for the Central Union at Elwood, Ind.

Glenn Stephens has been appointed manager of the Sherman County Telephone Company, Loup City, Neb., succeeding W. S. Waite, resigned.

C. H. Hood has resigned his position as contract agent for the Automatic Telephone Company, Chicago, to accept the position of assistant to President C. O. Frisbie. Mr. Hood will be succeeded as contract agent by George Markham, who has been identified with various telephone interests in the middle west for eighteen years. Mr. Markham was formerly contract agent for the Kinloch Company of St. Louis, but for the last six years has acted as special agent for the Chicago Telephone Company.

Edward E. Backus, Chicago, until recently sales engineer of the United States Electric Company, has been appointed superintendent of telegraph for the El Paso and Southwestern Railroad Company, with headquarters at Dallas, Tex. Mr. Backus has had extensive experience in telegraph and telephone operation, having been connected with some of the most important companies in the country. He will have direct charge of the operations and maintenance of telegraph and telephone lines and block signals.

Eugene H. Crowley, St. Louis, Mich., has been appointed manager of the Three Rivers Telephone Company, Three Rivers, Mich., to succeed Frank O'Brien, who has accepted a position with the Western Electric Company as salesman for the state of Michigan.

A. E. Huntley, of Ludington, Mich., for six years district manager of the Michigan State Telephone Company, has been promoted to the position of district manager of the Traverse City division. He will be succeeded in Ludington by J. J. Kelley, formerly of Grand Rapids.

L. P. Tood has been appointed manager of the Grant County Telephone Company, Milbank, S. D.

F. W. Wells, local manager of the Pacific States Telephone and Telegraph Company at Pendleton, Ore., has been promoted to the position of commercial manager of the company with headquarters at Walla Walla, Wash., to succeed C. W. Foster, who has accepted a position as special agent to the district commercial superintendent. Mr. Wells will be succeded by J. M. Skogmo.

Ira P. Watson has been appointed district contract agent of the New England Telephone and Telegraph Company, with headquarters at Augusta, Me.

W. A. Morgan has been placed in charge of the Humeston Telephone Exchange, Humeston, Ia., succeeding Geo. W. Patterson, who has been transferred to Corydon.

Irving L. Fisher has been appointed manager of the New England Telephone and Telegraph Company's exchange at Bangor, Me.

A. G. Mackenzie has been appointed publicity manager of the Mountain States Telephone and Telegraph Company, with headquarters at Salt Lake City, Utah.

H. Morgan has been appointed manager of the Pioneer Telephone Company's exchange at Yukon, Okla., succeeding W. W. Alexander, resigned.

John Cogdale has been appointed local manager of the Kananaugh Telephone Company, Effingham, Ill., succeeding E. H. Reece.

NEW TELEPHONE COMPANIES.

HARDY, ARK.—The Hardy Switchboard Company is the name of the new telephone company organized in this place, of which George Y. Green is president and T. C. Phillips, secretary.

HARRISON, ARK.—B. F. McCoid, P. S. Wood, William L. Ridinger and W. A. Brinkley have organized a company to construct a rural telephone system.

UNDERWOOD, CAL.—The Underwood Telephone Company has been incorporated with a capital stock of $2,000 by J. H. Hussey, M. Smith and H. Love.

ESCONDIDO, CAL.—The San Diego County Telephone and Telegraph Company has been formed at this place for the purpose of installing a telephone system in Escondido and vicinity. One hundred thousand dollars is named as the capital stock. The three trustees are C. N. Ambrose, James B. Carroll, Guy W. Wisdom. S. L. Thomason, until recently local manager of the Pacific Telephone and Telegraph Company, is also interested in the project. It is estimated that the system will cost $50,000. The new company is the result of dissatisfaction with the present service.

DOVER, DEL.—The United Telephone Company of Boston, with $5,000,000 capital, has been chartered by the State Department. The incorporators are John W. Long and Lester S. Smith, of Boston, and William N. Pyle, of Wilmington. The company is authorized to establish and operate telephone and telegraph lines and to transmit messages. Boston interests are behind the enterprise.

MERIDIAN, IDAHO.—Articles of incorporation have been filed for the Meridian Independent Telephone Company, with a capital stock of $25,000. The incorporators are S. McReynolds, Ivan S. Rice, J. A. Fenton, J. L. Waggoner, W. W. Groves, Henry Taylor and Clem Hedges.

PLUMMER, IDAHO.—The Plummer Home Telephone Company is the name of the new organization recently formed, with the following officers: President, F. H. McCaslin; vice-president, R. Malvon; secretary, R. L. Stout; treasurer, H. Mercer; general manager, R. A. Malcern.

OLGA, ILL.—The Olga Independent Telephone Company has been incorporated with a capital stock of $2,500 by Elwood Barker, S. E. Flannigan, Jr., and Lawrence Smith.

MACOMB, ILL.—The Macomb Telephone Company has been incorporated with a capital stock of $50,000 by Edw. Slusher, Chas. K. Todd and John C. Lawyer.

MASON, ILL.—Articles of incorporation have been filed for the Mason Rural Telephone Company by E. Hardsock, J. D. Wilson and L. N. Douglas. The capital stock is $2,400.

LINTON, IND.—The Vicksburg Mutual Telephone Company has been incorporated by W. F. Stockram, W. Neal and Elmer Pope. Capital stock, $2,500.

EVANSVILLE, IND.—The People's Telephone company capitalized at $19,000 by the filing of articles with the secretary of state. The incorporators are J. M. Lewis, G. L. Pierce and Wm. R. Woods, all of Evansville. Mr. Pierce is manager of the Postal Telegraph Company.

OFFERLE, KANS.—The People's Co-Operative Telephone Company has been organized with a capital stock of $10,000.

GAYHEART, KY.—The Gayheart Telephone Company has been incorporated by F. H. Gayheart, W. M. Gayheart and others with a capital stock of $1,000.

GLASGOW, KY.—The Beals Telephone Company has been incorporated with a capital stock of $100 by J. H. Beals, Joel Osborn, J. F. Pitcock and J. A. Marshall.

IRONTON, KY.—The Ironton Telephone Company has been incorporated by George Newton, W. T. Bloodworth, George Weaver, W. H. Rhodes, R. C. Morgan and Jim Newton, with a capital stock of $300.

SHORT CREEK, KY.—The Short Creek Mutual Telephone Company has been incorporated with a capital stock of $2,000 by D. M. Young, D. B. Young, S. T. Pryor, Isaac Ferry, S. H. Day, Willie Spurrier, John Bradshaw, J. M. White, S. J. Butler, Irvin Patterson, Sol Allen, Alonzo Payton, J. B. Mahurin, I. D. Mahurin, W. Young, W. F. Patterson, S. G. Day, R. H. McMullin, S. S. Shartzer, I. H. Day, Harvey Duggins, C. M. White and George Harrel.

WINGO, KY.—The Citizens' Telephone Company has been incorporated with a capital stock of $1,000 by Dr. W. M. Rozzell, Noblin Rozzell and W. T. Rozzell.

MELDER, LA.—The Melder-Forest Hill Telephone Company was recently organized at this place with a capital stock of $10,000 and the officers are as follows: President, H. B. Edwards, Jr.; vice-president, Joseph McGilvray; secretary and treasurer, H. O. Ponder. The above officers and T. C. Braddy and E. H. Patton. The headquarters of the company will be Forest Hill and lines will be extended to Uineston, Melder and Glenmore and the surrounding country.

CALAIS, ME.—The Eastern Telephone and Telegraph Company was recently incorporated with a capital stock of $200,000, to operate telephone and telegraph lines in Washington County.

The officers are as follows: President, W. S. Alexander, Eastport; treasurer, E. E. Talbot, Machias.

Chelsea, Mich.—The Chelsea Home Telephone Company has been incorporated with a capital stock of $20,000.

Vermontville, Mich.—A new telephone company has been organized at this place with James Andrews president and J. C. Downing secretary. Fully $10,000 has already been subscribed and it is planned to capitalize the company at $25,000.

Norwood, Mich.—The Norwood Telephone Company has been organized with the following officers: President, J. H. Bugbee; vice-president, Frank E. Richardson; secretary and treasurer, James C. Chase; directors, Amidon Stafford and Henry Brown.

Long Prairie, Minn.—The Roddis Telephone Company has been organized with the following officers: President, David Roddis; vice-president, Louis H. Roddis; secretary and treasurer, G. B. Roddis.

Guthrie, Minn.—Articles of incorporation have been filed for the Guthrie Mutual Telephone Company with a capital stock of $10,000. The incorporators are Fred Wolf, C. E. Hedman and others.

Lynwood, Miss.—The Lynwood Telephone Company has been incorporated by W. G. Thompson, L. G. Collier and others with a capital stock of $250.

Columbia Falls, Mont.—The Columbia Falls Telephone Association has been incorporated with a capital stock of $40,000 by C. C. Miller, H. E. Kennedy and others. The company contemplates the installation of lines all over the county, with headquarters in this city.

Walkertown, N. C.—The Walkertown Telephone Company has been incorporated by J. C. Mammock and others with a capital stock of $5,000.

Stem, N. C.—F. B. Hampton, A. S. Carrington, J. H. Stem and others are the incorporators of the Rural Telephone Company in this place, capitalized at $50,000.

Avoca, N. Y.—Articles of incorporation have been filed for the Nills Creek Telephone and Telegraph Company with a capital stock of $1,000. The directors are Loren H. Palmer, George D. Dockstader and Norman C. Demorest, of Howard; Nina C. Bowen and Wm. P. Rowe, of Avoca; G. D. Silsbee and Austin Evans, of Fremont.

Forman, N. D.—The Forman, Rutland and Havana Telephone Company has been incorporated with a capital stock of $10,000. The incorporators are John Powers, of Havana, and A. E. Land and H. O. Gardner, of Forman.

New Washington, O.—Articles of incorporation have been filed for the Cranberry Home Telephone Company with a capital stock of $10,000. The incorporators are J. H. Donaldson, A. G. Lederer, O. L. Green and John H. Sharp.

Columbus, O.—For the purpose of manufacturing a spraying device and a disinfectant to disinfect telephone mouthpieces, the Only Telephone Disinfectant Company has been incorporated with a capital stock of $10,000 by Charles H. Willis, Llewellyn Adams, Russell B. Adams, Herbert G. Payne and Nannite Payne.

Franklin, O.—The Home Telephone Company has been incorporated with a capital stock of $2,000 by J. L. Dobson, W. C. Peterson and others.

Olive, Okla.—The Bristow and Olive Telephone Company has been incorporated with a capital stock of $500 by W. T. Wilson, H. G. Matherly, J. H. Dumas and C. S. Burnes, all of Olive.

Morge, Okla.—The Farmers' Mutual Telephone Company of Grady County has been incorporated with a capital stock of $600 and the directors are as follows: H. A. Bloss, Cement; L. Delp and A. H. Nelson, Chickasha.

Gage, Okla.—The Gage Northwestern Telephone Company has been incorporated with a capital stock of $1,500 by J. M. Bateman, R. P. Cannon and Ira Shaffer, all of Gage.

Caney, Okla.—The Oklahoma Rural Telephone Company has been incorporated with a capital stock of $10,000. The incorporators are A. H. Utley, of Caney; J. W. Craig, McAlester, and C. J. Dupius, Coalsgate.

Prineville, Ore.—The Oregon Central Telephone Company has been incorporated with a capital stock of $50,000 by Louis Dooner, O. R. Cook and N. W. Sanborn.

Warrensville, Pa.—The Blooming Grove Telephone Company has been incorporated with a capital stock of $5,000.

Roxton, Tex.—The Roxton Independent Telephone Company has been incorporated with a capital stock of $9,000 by McD. High, Brooks Ware and W. J. Bradshaw.

Cheyenne, Wyo.—The Cheyenne Automatic Telephone Company has filed articles of incorporation with the secretary of state. The capital stock is $175,000. The incorporators are W. C. Mentzer, Robert N. LaFontaine and N. D. Smith.

Sylvatus, Va.—The Reed Island Mutual Telephone Company has been incorporated, with Dr. I. W. Surratt, president; J. L. Marshall, vice-president; J. E. Marshall, Mecca, secretary and treasurer. Capital stock: Maximum, $5,000; minimum, $500. It is the purpose to build and operate a telephone line.

Lone Oak, Tex.—The Lone Oak Telephone Company has been incorporated with a capital stock of $1,600 by W. T. Nolen, Sr., J. R. Hunt and F. M. Myrick.

Welch, W. Va.—The McDowell County Telephone Company has been incorporated with a capital stock of $25,000 by W. P. Hawley, of Bluefield; F. J. F. Strothem, W. W. Hughes and James A. Henchey, of Welch, and Charles F. O'Neil, of Buffalo, N. Y.

Innerkip, Ont.—The Innerkip Rural Telephone Company, Limited, has been incorporated with a capital stock of $25,000. The provisional directors are Dr. John Hossack, James Bicknell and Dr. Alexander Nichol Hotson, all of East Zorra.

Port Stanley, Ont.—Among the new telephone companies incorporated recently are the Port Stanley Telephone Company, Limited, with headquarters at Port Stanley, and the Russel Rural Telephone Company, Limited, in the county of Russell.

Tuscumbia, Ala.—A mortgage for $50,000,000 was recently filed for record in the probate office by the Southern Bell Telephone and Telegraph Company in favor of the Bankers' Trust Company of New York and John H. Parsons, trustee. The instrument covers seventy-five printed pages, and the cost alone in the county for recording was something aver $200. Wherever the company operates the mortgage must be filed, and practically every county in the state will record the instrument. The mortgage tax, which is five per cent, amounted to $2,925. The mortgage tax covers a period of thirty years, and the bonds bear interest at the rate of five per cent per annum. The money secured on the mortgage will be used solely for the making of acquisitions, extensions and improvements of the telephone company's property.

Clinton, Ia.—At a meeting of the directors of the Tri-City Telephone Company on the 21st ult., the regular semi-annual dividends were declared, making the fifteenth dividend declared under the present management. The officers of the company are as follows: President, A. G. Hawley; vice-president, Milo J. John; secretary and treasurer, Chas. B. Cheadle; directors, the above officers and Geo. W. Allen, J. H. Peters, J. O. Barrett, V. G. Coe, F. J. Spencer and L. C. Moeszinger.

Trump, Ind.—The Public Service Commission has granted the Union Telephone Company permission to issue $1,000 worth of stock to pay for improvements already made.

Kirksey, Ky.—The Kirksey Telephone Company has increased its capital stock from $1,000 to $2,500.

Prestonsburg, Ky.—The capital stock of the Sandy Valley Telephone Company has been increased from $5,000 to $10,000 for the purpose of constructing additional toll lines.

Jackson, Ky.—The Jackson Home Telephone Company has increased its capital stock from $6,000 to $10,000 for the purpose of constructing additional lines in the county, also, a line from this place to Whitesburg, a distance of ninety miles.

Whitesburg, Ky.—The capital stock of the Letcher County Telephone Company has been increased from $2,000 to $3,000, and additional lines will be built.

Pine Top, Ky.—The Carr's Fork Telephone Company has increased its capital stock from $3,500 to $5,000 and will build a metallic line from this place to Hindman and Sassafras. S. R. Blair is manager of the company.

Homer, Mich.—The capitalization of the Homer Telephone Company has been increased from $35,000 to $75,000.

Houston, Tex.—The Telephone-Electric Company has filed an amendment with the secretary of state increasing its capital stock from $50,000 to $100,000.

Velasco, Tex.—The Brazos Telephone Company has amended its charter, decreasing its capital stock from $10,000 to $5,000.

RATES.

Colusa, Cal.—The subscribers of the Colusa County Telephone Company will resist the proposed increase of rates effective October 1st. A petition will be presented to the company, asking that the present rates be continued, or every signer will ask the removal of his telephone. The company claims that at the present rates it cannot more than pay expenses.

Springfield, Mo.—The city council has decided to accept the compromise offered by the Ozark Bell Telephone Company and as a result the company announces that $400,000 has been set aside for the improvement of the plant in this place. The concessions of the company for a franchise to run eleven years included a reduction in rates from $42 per year to $36 for

business telephones, and from $24 to $22 for residences, and, also, the payment of all costs in litigation previous to the acceptance of the compromise, amounting to about $15,000, and the annual payment of $1,000 to the city during the life of the franchise, and in addition the company agrees to build a $200,000 telephone plant within twelve months.

MONROE, LA.—If the people of Monroe will consent to an advance of 25 cents per month on business telephones now within the city limits, The Cumberland Telephone Company will at once begin the installation of a common battery system in that city, which will cost in the neighborhood of $60,000.

LEWISTON, IDAHO.—The Pacific States Telephone and Telegraph Company has announced an increase in rates on four-party lines, and a number of subscribers will present the matter to the council, contending that, considering the service rendered, the present rate of $1.25 a month is sufficient.

MACON, MO.—The Macon Telephone Company has announced its intention of increasing its rates from $2 to $2.50 on business and $1 to $1.50 on residence telephones, claiming that under the new franchise the increase is permitted upon its agreement to add rural service without extra cost, while the city claims to have legal authority to fix a maximum charge.

BARTLETTSVILLE, OKLA.—The Pioneer Telephone Company has increased its rates in this city from $1. to $2 on residence lines and from $2.50 to $3 on business lines. These rates were established in October, 1908, but have never been collected owing to court proceedings based on the charge of the city that the service did not justify such increase. The plant has recently been improved and put in first-class order.

PIERRE, S. D.—At the September meeting of the state railway commission a good share of attention was given to telephones. The application of the Dakota Central Telephone Company to increase its rates at Tyndall and Mellette was denied, while the companies at Canistota and Centerville were allowed to make the increase.

PORTAGE, WIS.—The People's Telephone Company has asked permission of the state commission to increase its rates.

FRANCHISES ASKED AND GRANTED.

SEARCY, ARK.—R. A. Ward, Sr., who formerly owned the telephone system in this place, has asked for a franchise for an entirely new system. The franchise for the present system has expired and the present owners propose rebuilding and greatly improving the system before asking for a franchise.

LIBERTYVILLE, ILL.—Frank B. Lowell and Fletcher Clark, of the Lake County Telephone Company, have been granted a franchise in this place. They have asked for permission to maintain a service in Lake County.

MACOMB, ILL.—At a meeting of the city council the Western Illinois Telephone Company was granted a franchise.

ATHENS, ILL.—The People's Telephone and Telegraph Company has been granted a franchise in this place.

EVANSVILLE, IND.—The Evansville Independent Telephone Company has asked for a twenty-five-year franchise in this city.

WINCHESTER, IND.—At a special meeting of the city council the franchise for exchange service only of the Farmers' Telephone Company was passed, which ends a long fight for the farmers.

MORAN, KANS.—The Bayard Mutual Telephone Company has asked the city council for a twenty-one-year franchise to build and operate another telephone system in this place.

FRANKLIN, KY.—After months of strenuous effort the Farmers' Telephone Company has been granted a franchise.

LANESBORO, MINN.—The Farmers' and Merchants' Telephone Company has been granted a franchise to install a telephone system here.

LAUREL, MISS.—The Jones County Rural Telephone Company has been granted a franchise to install a telephone system in this place.

BOONEVILLE, MO.—A franchise has been granted the Booneville Telephone Company to install a system in this place. The rates, as fixed by the council, are $1.50 for residence and $2.50 for business telephones.

BRAYMER, MO.—The Regal Telephone Company has asked for a franchise in this place.

ABERDEEN, S. D.—The board of county commissioners of Ziebach County has granted a telephone franchise to F. E. Stevens to connect the various towns in the county by telephone.

Permission has been granted the maple Leaf Telephone Company to extend its lines.

NEWPORT, WASH.—J. W. Fisher, manager of the Interstate Telephone Company, has applied for a franchise in this city.

KALAMA, WASH.—The Cowlitz Bend Telephone Company has been granted a franchise by the board of county commissioners.

DAYTON, WASH.—The Mount Vernon Telephone Company has applied for an exclusive franchise in this city.

VANCOUVER, WASH.—Lawrence Harmon has applied for a franchise for the installation of a telephone and telegraph system, also for constructing a street car system.

BOUNDARY, WASH.—The Cedar Creek Independent Telephone Company, with principal office in this place, has asked for permission to construct a system of telephone lines.

CAMERON, W. VA.—The County Court has granted the Union Farmers' Telephone Company a franchise to construct telephone lines out of Cameron.

CHEYENNE, WYO.—Franchises are being sought in this city by the Mountain States Telephone and Telegraph Company and the Cheyenne Automatic Telephone Company.

SPRINGDALE, ARK.—The North Arkansas Telephone Company will improve its Huntsville exchange, which will include the installation of a new and larger switchboard.

LONG BEACH, CAL.—The Pacific Telephone and Telegraph Company will install a conduit system in connection with its new exchange at an estimated cost of $150,000.

COURTLAND, CAL.—The new Freeport Telephone and Telegraph Company will erect a new exchange and will install a new switchboard.

LOS ANGELES, CAL.—The Guaranty Pipe Line Company will construct a telephone line from the Midway oil fields to Ventura, at an estimated cost of $15,000.

SAN FRANCISCO, CAL.—Plans have been prepared by the Pacific Telephone and Telegraph Company for an exchange building in the Sunset District at an estimated cost of $30,000.

LOUISVILLE, KY.—In order to meet increased demands for service the Louisville Home Telephone Company contemplates the installation of a large branch exchange, which will have an ultimate capacity of 10,000 lines.

SHREVEPORT, LA.—The Cumberland Telephone and Telegraph Company, which has just expended $200,000 in improvements, announced that an equal amount will be spent in placing its wires underground in the business section of the city.

SLEEPY EYE, MINN.—The Tri-State Telephone Company, in connection with a company formed in this place, of which Wm. Brust, Chas. Cutting, F. J. Ridl and C. A. Fobes are directors, wil linstall a telephone system in this place.

MARYVILLE, MO.—The Hanamo Telephone Company will make a number of improvements in its system, including the construction of underground conduits in the business section of the city and additional toll lines.

PORTLAND, ORE.—C. H. Moore, district superintendent of the Pacific Telephone and Telegraph Company, announces his company will shortly begin the erection of an additional line, which will involve an expenditure of between $15,000 and $20,000.

MITCHELL, S. D.—The Dakota Central Telephone Company will install a new plant.

MAIDEN ROCK, WIS.—The Lake Pepin Telephone Company will erect an exchange building which will serve as headquarters for the company's entire business.

MISCELLANEOUS.

EVENING SHADE, ARK.—The Sharp County Telephone Company has been purchased by W. T. Flynn, of Jameston, who owns several telephone lines in Independence and Jackson Counties.

NASHVILLE, ARK.—The Nashville Telephone Company has been purchased by the Lesser-Goldman Cotton Company and the same will be in charge of Virgil Owen.

DENTON, MD.—The Farmers' and Merchants' Telephone Company, which operates all the telephone lines in Caroline, Talbot and Queen Anne counties, has purchased a site in this place on which it will erect a new exchange building.

MARSHALLTOWN, IA.—The Merchants', Mechanics' and Farmers' Telephone Company has effected a permanent organization by electing the following officers: President, F. M. Wheeler; vice-president, Robert Harper; secretary, Edward F. Peek; treasurer, J. P. Cooper; directors, M. E. Melvin, F. E. Dewitt, N. A. Evans, L. E. Williams, Charles Lynch, Carver Ferguson, Henry Goecke, Jr., S. T. Cooper, F. C. Davis, C. J. Ogler and Joseph Haynes.

QUINTER, KANS.—The Gove County Telephone system has been purchased by a syndicate headed by Homer Foltz of Topeka. It has been incorporated as the People's Telephone Company and will be under the management of R. R. Lewis. The system will

be practically rebuilt and put in first class condition. It is one of the largest independent systems in the state.

Baltimore, Md.—An appropriation of $26,000 has been made by the Chesapeake and Potomac Telephone Company to be used for replacement work and construction in trunk lines.

Sleepy Eye, Minn.—The Sleepy Eye Rural Telephone Company will build an exchange in this place.

Greenfield, Mo.—The Dade County Telephone Company has disposed of its Greenfield exchange to F. J. McComb, a telephone man of long experience, for a consideration of $5,000.

Buffalo, N. Y.—Papers have been filed with the county clerk showing the transfer of all the long distance telephone lines and properties of the Independent Union Telephone Company west of Syracuse to the Federal Telephone and Telegraph Company.

Lenoir, N. C.—The Lenoir Electric Company, owners of the local telephone system, have sold the same to a company composed of Lenoir and Hickory people, who will make a number of improvements including the cabling of the lines.

Fargo, N. D.—The Northwestern Telephone Exchange Company contemplates extensive improvements, including the installation of a conduit system.

Ambrose, N. D.—The Divide County Farmers' Telephone Company will erect an exchange in this place.

Oklahoma City, Okla.—The Oklahoma Telephone Association recently held its semi-annual convention in this city. The main subjects discussed were improvements in long distance service and the extension of service into every rural district. The officers elected were R. S. Goff of Sulphur, president, and Horace Truman of Purcell, secretary.

Mulhall, Okla.—The Farmers' Telephone Company, formerly operated by E. D. Wilkerson, has been taken over by R. M. Kincaid, who has greatly improved the same.

Independence, Oreg.—The Home Telephone Company, owned by W. L. Rice, has been sold to Clyde D. Carlos of Portland, who will make extensive improvements in the system and extend the lines to different parts of the country. A new switchboard will be installed.

Allentown, Pa.—A Bondholders' Protective Committee composed of John Graham, Pittsburg; A. P. Trautwein, Carbondale, and E. T. Clymer and J. N. Thompson of Philadelphia, has been formed to take the properties of the Consolidated Telephone Companies of Pennsylvania out of the hands of the receivers and place them on a paying basis. The properties involved and the amount of bonds outstanding are as follows: Consolidated Telephone Companies of Pennsylvania, $50,000; Berwick Telephone Company, $50,000; Honesdale Telephone Company, $40,000; Lackawanna Telephone Company of Scranton, $421,000; Lehigh Telephone Company of Allentown, $170,000; People's Telephone Company of Wilkesbarre, $243,000.

Rockham, S. D.—The Rockham Telephone company, having exchanges at Rockham, Zeil and Miranda, has been purchased by the Dakota Central Telephone Company of Aberdeen.

Waco, Tex.—The Home Telephone Company has been succeeded by the Brazos Valley Telephone Company and the capital stock has been increased to $200,000.

Lone Oak, Tex.—The Lone Oak Rural Telephone Company has been purchased by the Citizens' Telephone Company of this place.

Austin, Tex.—The Southwestern Telegraph and Telephone Company has purchased the property of the Texas Telegraph and Telephone Company, consisting of six local exchanges and 400 miles of toll lines, the consideration being $60,000. The exchanges are located at Burnett, Llano, San Saba, Marble Falls, Fredericksburg and Mason. It is announced the entire system will be rebuilt.

Portland, Tex.—The Portland-Rosita Telephone system has been purchased by Messrs. Arnold and Rachal, who are rebuilding and otherwise improving the same.

The Twin City Telephone Company contemplates the expenditure of $25,000 to $35,000 in improving its system in this place, in the near future. R. A. Klinge is manager of the company.

Elkhorn, Wis.—The Elkhorn exchange of the Wisconsin Telephone Company has been purchased by the Elkhorn Independent Telephone Company.

Ripon, Wis.—At a meeting of the stockholders of the Ripon Telephone Company, G. F. Horner was elected president, to succeed T. S. Chittenden, deceased. D. V. N. Harwood, vice-president, W. T. Runals, treasurer and S. M. Pedrick, secretary and general manager. Officers of the Ripon Rural Telephone Company chosen were J. B. Barlow, Jr., president; Lewis Pinch, vice-president, W. T. Runals, treasurer, and S. M. Pedrick, secretary general manager. The affairs of both companies were shown to be in a flourishing condition.

Abbeville, Ga.—The Abbeville telephone system has been purchased by William R. Bowen, who also owns the Fitzgerald and Rochelle telephone systems, for a consideration of $5,000. The system will be improved.

Lavonia, Ga.—A deal has been consummated whereby A. B. Vickery, proprietor of the telephone system at this place, has disposed of his interests to Cam Dorsey for $10,000.

Cotcoran, Cal.—The local business of the Pacific Telephone and Telegraph Company has been purchased by William Cromlie.

Ducor, Cal.—The Duco-Hot Springs Telephone Company, recently organized, has elected the following officers: President, L. S. Wingrove; vice-president, F. M. Carlisle; secretary and treasurer, H. C. Carr, of Porterville.

Washington, D. C.—The U. S. Navy Department is preparing to extend the Alaska wireless telephone system, and a station will be erected on one of the Aleutian Islands.

Decatur, Ind.—The Citizens' Telephone Company recently held its annual meeting and reports showed the company to be in excellent condition. The past year has been a very prosperous one and the usual eight per cent dividend was declared. The old officers were re-elected as follows: President, J. S. Bowers; vice-president, J. T. Merryman; secretary and treasurer, F. M. Schirmeyer.

Davenport, Ia.—Plans have been completed for a new $75,000 office building to be erected at Sixth and Main streets by the Iowa Telephone Company.

Charles City, Ia.—The Western Electric Telephone Company contemplates the expenditure of $40,000 in extending and improving its plant.

Webster City, Ia.—The toll lines of the Martin Telephone Company of this city, comprising some thousand miles of wire, have been purchased by the Iowa Telephone Company.

Dexter, Kans.—The Missouri and Kansas Telephone Company has sold its exchange at this place to H. S. Burden.

Portland, Me.—During the next twelve months the New England Telephone and Telegraph Company will spend about $250,000 in improving its service in this city, and later about $30,000 additional will be spent by the company for cable facilities through the various streets of the city.

Alpena, Mich.—The Alpena Mutual Benefit Telephone Company has been purchased by M. Y. Streeter, said to represent other interests.

Grand Rapids, Mich.—At the annual meeting of the Michigan Independent Telephone and Traffic Association the following officers were re-elected: President, C. E. Tarte, Grand Rapids; vice-president, W. J. Melchers, Alma; secretary and treasurer, C. W. S. Vivian, Grand Rapids.

Grand Rapids, Mich.—As shown by the annual report of the Citizens' Telephone Company, gross earnings for the past year were $718,841.11, an increase of more than $40,000 over a year ago. The following directors were re-elected: C. F. Rood, Edward Fitzgerald, E. B. Fisher, William J. Stuart, Philip Graham, Cyrus E. Perkins, Lester J. Rindge, R. D. Grahan, Gaius W. Perkins, John B. Martin and Joseph B. Ware.

St. Peter, Minn.—Negotiations are pending for the purchase of the system operated by the Nicollet County Telephone Company by the Tri-State Telephone Company. The system consists of eight exchanges and over 500 miles of toll lines. It is capitalized at $100,000.

Hannibal, Mo.—The Bluff City Telephone System has been purchased by Ben C. Hyde, of Kansas City, who contemplates enlarging the plant.

Springfield, Mo.—A long-distance copper circuit telephone line from Springfield to Memphis will be built by the Ozark Bell Telephone Company at a cost of $100,000, work to begin within thirty days.

Portland, Ore.—The Pacific Telephone and Telegraph Company will erect an eight or ten story class A building at the southeast corner of Park and Oak streets, to cost not less than $250,000.

Dyersburg, Tenn.—The Home Telephone Company, a corporation owned by farmers of Dyer County, will install an exchange in this place.

Lone Oak, Tex.—The Lone Oak Rural Telephone Company has been purchased by the Citizens' Telephone Company of this place.

Aberdeen, Wash.—The Pacific Telephone and Telegraph Company will erect a building on Market street at an estimated cost of $35,000.

Pasco, Wash.—The Twin City Telephone Company has completed plans for the installation of a new system, which, according to R. A. Klinge, manager of the company, will mean an expenditure of about $30,000. Ultimately all wires will be placed underground.